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Toward "AI-Centered Student": Making Sense of Learning Environment, Epistemic Beliefs, and Self-Regulated Learning Using Epistemic Network Analysis

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Abstract: This preliminary study is designed to explore the multifaceted impact of Generative Artificial Intelligence (GenAI) integrated into digital learning platforms, namely AISI, on students' science learning, self-regulation, and epistemic beliefs from 129 college students. Leveraging empirical study data, Epistemic Network Analysis (ENA) was utilized to quantitatively explore relationships between students' learning preferences (high AI-centered preference group and low AI-centered preference group), their epistemic beliefs concerning AI (certainty, justification, complexity), and their self-regulated learning strategies (adaptation, planning). The findings show that students in the high AI-centered preference group tend to believe that knowledge provided by GenAI is uncertain and complex. This study aims to contribute to GenAI-enhanced learning environments and pedagogical practices that foster critical AI literacy and adaptive self-regulated learning.

Keywords: Generative Artificial Intelligence (GenAI), AI-centered student, Epistemic Network Analysis (ENA), Self-regulated Learning (SRL), epistemic beliefs

1. Introduction

GenAI is transforming education by providing personalized learning experiences through instant feedback, large-scale data processing, and predictive insights (Yang, 2022). Several studies have shown the effectiveness of GenAI in science education. For instance, El Fathi et al. (2025) found that integrating GenAI into STEM education improved students' conceptual understanding while reducing misconceptions during learning. In addition, GenAI tools such as ChatGPT have been shown to increase teachers' confidence in creating educational resources, designing lesson plans, and enhancing productivity (Cordero et al., 2025). However, these benefits are accompanied by concerns regarding accuracy, including the lack of supporting evidence and the generation of inaccurate references (Cooper, 2023).

The advancement of GenAI, particularly in the domain of education, may create a new dimension of teaching approaches that go beyond the traditional student-centered and teacher-centered models. This emerging dimension has been termed as "AI-centered approach", which is highly correlated with self-regulated learning (SRL) and students'

epistemic beliefs. However, there is a need to explore in greater depth the perspectives of students who prefer AI-centered learning. There were SRL adaptation and planning assessed in this study, which investigated how students set the learning goals and plan their own learning. Moreover, students adjust their strategies to overcome obstacles during the learning process (Winne & Hadwin, 1998; Zimmerman & Moylan, 2009). On the other hand, we assessed student epistemic beliefs justification to justify how learners justify the credibility of GenAI-generated knowledge (Hofer & Pintrich, 1997; Muis, 2007; Schommer-Aikins, 2004). Epistemic beliefs complexity to investigate students' perceptions of the depth and detail of knowledge presented by GenAI. Epistemic beliefs, certainty and source to investigate how individuals perceive the certainty and reliability of knowledge provided by GenAI.

In our previous findings using Canonical Correlation Analysis found that AI-centered learning tend to believe that information from GenAI is certain and complex. On the other hand, they demonstrated moderate levels of justification, alongside SRL adaptation and planning. To investigate this finding deeper, we conducted a qualitative analysis utilizing Epistemic Network Analysis (ENA) on students' open-ended responses. **Research Question**: *How do students make sense of knowledge and regulate themselves when learning with GenAI?*

2. Method

2.1 Participants

There were 129 (100 females and 29 males) college students involved in this study, majoring in Primary Education at Zhejiang Province, China. Participants were enrolled in Biology course during data collection. Participants were recruited voluntarily, and informed consent was obtained, ensuring ethical compliance with the research standard.

2.2 Intervention

Students engage with the AISI (Adaptive Interactive Study Interface) platform https://aisi.tw/login/index.html that leverages Generative AI (GenAI) to provide personalized learning support for students and intelligent teaching tools for educators. The GenAI features within AISI are designed to provide personalized support, explanations, and feedback, fostering an interactive learning experience.

The intervention involved students completing their regular Biology homework assignments within this platform. Specifically, the AISI platform implements an innovative AI-supported learning model guides students through a complete learning cycle: Test → self-assessment → AI-supported feedback → revised test (see Figure 1). In this cycle, students first complete an assignment, then engage in self-assessment of their performance. Following this, the GenAI provides immediate and personalized feedback designed to help students calibrate their self-assessments and understand areas for improvement. Students revise their work based on this feedback, completing a revised assignment. Its goal is to build a learning environment capable of offering real-time adaptive scaffolding and generative AI feedback.

2.3 Analysis

To examine to what extent students make sense of the knowledge and regulate themselves during learning with GenAI, we administered open-ended questions to the students. The questions are:

How does GenAI help you learn better? *(Include specific examples: when you use GenAI, how you use it, learning goals it helps you reach, or outcomes it improves.)*
What limitations do you think still exist in GenAI-assisted learning?
What concerns or doubts do you still have about GenAI-assisted learning?

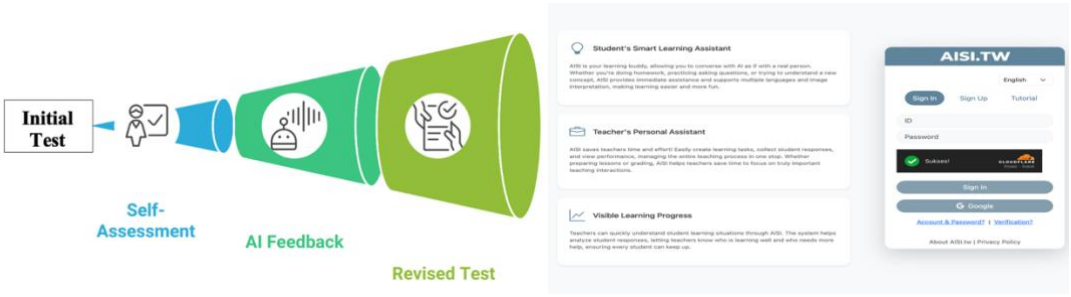

Figure 1. AI-supported learning model through AISI

The open-ended question responses underwent rigorous thematic analysis. This process identified recurring patterns, specific examples, and nuanced perceptions related to the benefits, limitations, and concerns of GenAI in science learning. Epistemic Network Analysis (ENA) was then applied to construct networks representing the co-occurrence of the defined constructs: *EC* = Epistemic Beliefs – Complexity; *ECS* = Epistemic Beliefs – Certainty and Source; *EJ* = Epistemic Justification; *SA* = Self-regulation adaptation; *SP* = Self-regulation planning. ENA was also used to compare network structures across different initial learning preference groups (high-AI–preferred and low-AI–preferred). This comparison helped determine whether students who initially favored student-centered (high-AI–preferred and low-AI–preferred) exhibited distinct patterns of AI engagement and self-regulation after using the GenAI-integrated platform.

3. Findings

The findings from the ENA revealed in general, students with AI-centered learning preferences demonstrated strong ECS, EC, and EJ, and these three factors appeared to be highly correlated with SA. SVD1 is 22.6% of the variance in coding co-occurrences along the x-axis and SVD2 is 20.0% of the variance on the y-axis.

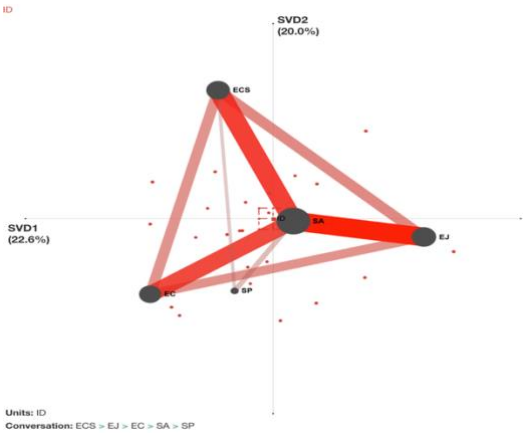

Figure 2. Co-occurrence of ECS, EJ, EC, SA, and SP among participants

There was a significant difference between the groups. Students with a high AI-centered preference tended to believe that knowledge provided by GenAI is uncertain (see Figure 3). In addition, students stated:

AAA41110A: *"I worry about the accuracy of the answers."*

AAA41112B: *"Some information may be inaccurate or vaguely expressed."*

This implies that students with high AI-centered preferences developed beliefs toward GenAI knowledge as uncertain. In other words, students in this group often questioned the accuracy or validity of the information provided by GenAI. These results align with the study by Chan and Hu (2023), which revealed that students who used GenAI for personalized learning support, writing, and brainstorming assistance, including research and analysis, expressed concerns about the accuracy, privacy, and ethical issues associated with utilizing GenAI.

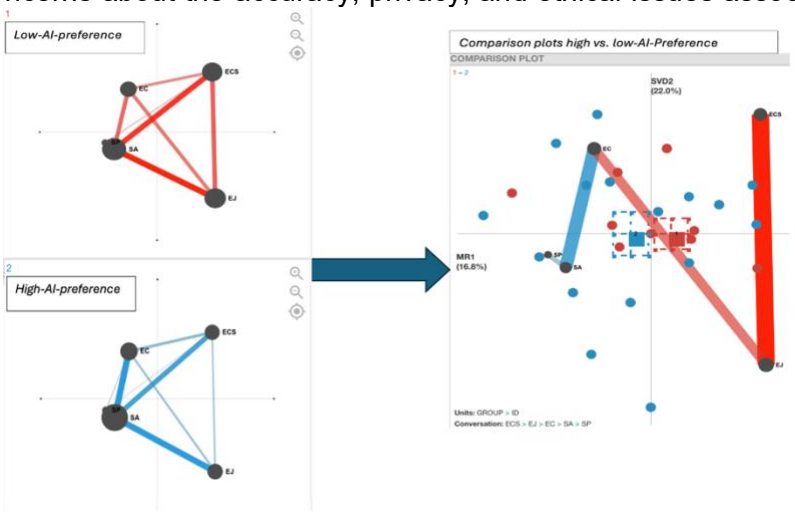

Figure 3. Comparison plot between the high (blue) and low AI-preference (red) groups. SVD1 is 16.8% of the variance in coding co-occurrences along the x-axis and SVD2 is 22.0% of the variance on the y-axis

High-AI-centered students also see knowledge provided by GenAI as more complex (see comparison plot, as EC is stronger in the strong AI-centered preference group). Furthermore, students with high AI preference reported that the knowledge provided by GenAI is complex.

AAA104112D: *"Helps with problem-solving and giving more complete answers."*

AAA041121E: *"I use it when I have questions, ask it directly for a detailed explanation."*

Students in this group developed a belief that GenAI could provide them with complex answers or knowledge. For example, student AAA104112D stated that GenAI is helpful in problem-solving tasks and provides complete answers. This result aligns with existing research suggesting that GenAI may be helpful for problem-solving, although it may not completely replace the process of constructing complex knowledge. For instance, Obafemi et al. (2025) concluded that AI can synthesize knowledge from different domains and use it to propose multiple problem definitions.

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Note. Due to space limitations, not all relevant references are included in this article. Additional references are available upon request.