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Understanding the Application of GenAI in Higher Vocational Education: A Perspective on Students' Deep Learning Behavior

Hang Chen [1], Hongchao Zhang [2,*]

[1] Faculty of Cross-Border E-Commerce, Shenzhen Polytechnic University, Shenzhen, China

[2] School of Economics and Management, Chongqing University of Posts and Telecommunications, Chongqing, China

[*] Corresponding author

Abstract

The integration of generative artificial intelligence (GenAI) is reshaping teaching and learning in higher vocational education. Using Activity Theory as the analytical framework, this study explores how GenAI influences the emergence of deep learning among vocational students. This study proposes that GenAI supports deep learning by enhancing cognitive scaffolding, improving interaction quality, strengthening emotional and social support, and enabling more efficient human–AI collaboration. At the same time, risks such as over-reliance and reduced critical thinking remain. This study provides a clearer understanding of how GenAI affects vocational students' deep learning and offers implications for designing more effective AI-supported learning environments.

Keywords

Deep learning behavior; Generative artificial intelligence; Higher vocational education.

1. Introduction

Deep learning is not only concerned with students' higher-order understanding of knowledge but is also essential for the development of cross-context transfer, problem-solving, and innovation capabilities. It has thus become a key indicator of quality enhancement in higher education(Chaudhary and Singh, 2025). With the ongoing advancement of undergraduate-level vocational education, higher vocational education is undergoing a transformation from a skill-oriented model to a competency-oriented one, making it urgent to construct instructional mechanisms that effectively stimulate students' deep cognitive processing(Huang, 2025). Although existing studies have provided comprehensive insights into the connotations and influencing factors of deep learning, limited attention has been paid to specific context of vocational education. Compared with traditional undergraduates, higher vocational students possess distinct characteristics in terms of learning motivation, vocational orientation, and self-directed learning ability (Chukwuedo and Mbagwu et al., 2021), which impose differentiated requirements on the conditions that support the occurrence of deep learning.

Meanwhile, GenAI has been widely adopted for instructional support, resource integration, and personalized learning path design. However, despite these advantages, GenAI also introduces new challenges to fostering deep learning (Levin and Marom et al., 2025). Students may become overly reliant on AI-generated ready-made answers leading to mechanical imitation and superficial engagement, which in turn weakens their independent thinking and critical analysis abilities.

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To solve the above issue, the present study employs activity theory as analytical framework and, drawing on the distinctive characteristics of vocational education, analyzes emergence of deep learning among students in the context of GenAI integration.

2. Literature Review

2.1. Research on Deep Learning in Education

2.1.1. Definition and Characteristics of Deep Learning

As a learning orientation, 'deep learning' not only emphasizes the construction of learners' knowledge systems but also involves the cultivation of higher-order thinking and the formation of values. It highlights learners' ability to understand, transfer, and reconstruct knowledge, with its core lying in stimulating cognitive engagement, autonomous inquiry, and critical thinking (Biggs, 1999).

In education contexts, deep learning refers to a meaningful learning process in which students, under the guidance of teachers, engage fully and concentrically with challenging learning tasks. It underscores the deep understanding and application of knowledge rather than mere memorization or repetition. In contrast, surface learning is often characterized by mechanical memory and passive reception, which fail to support students' long-term developmental needs.

2.1.2. Factors Influencing Deep Learning

Teachers play a critical role in the process of deep learning (Song and Yang et al., 2022). Their function extends far beyond transmitting knowledge, serving as facilitators and supporters of students' learning processes. A substantial body of research has shown that well-designed teaching contexts and learning tasks serve as key drivers of deep learning, effectively helping learners grasp the organic connections between bodies of knowledge (Rajaram, 2023).

Effective teaching methods also play a decisive role in determining whether students can achieve deep learning. The occurrence of deep learning requires the use of problem-based, situational, task-driven, and project-based instructional strategies to optimize the learning process. A meta-analysis conducted by Wang et al. (2022) found that instructional interventions exert significant positive effects on students' deep learning, with peer feedback, project-based learning, situational tools, and case-based instruction being particularly effective. Therefore, selecting appropriate pedagogical methods—especially those that stimulate students' autonomy and creativity—is essential for fostering deep learning.

A conducive learning environment is also essential for the occurrence of deep learning, including the construction of physical, behavioral, and contextual dimensions. The development of deep learning environments requires not only adequate physical conditions but also behaviorally aligned settings that correspond to students' cognitive characteristics, as well as contextual environments that support self-development. High-quality learning environments offering supportive conditions and positive social interactions can significantly enhance students' cognitive and emotional development, thereby promoting the realization of deep learning (Rusticus and Pashootan et al., 2023). Technology-enhanced learning environments can enhance students' motivation (Wang and Huang, 2025), especially when they afford high levels of interactivity and situational interest, leading to improved deep learning outcomes.

With the advancement of information technology, the integration of digital technologies in education has become an important means of facilitating deep learning (Wu, 2024). The development of digital instructional materials in vocational education aligns with students' learning characteristics and provides a foundational platform for deep learning. Digital technologies offer personalized learning paths, enrich instructional resources, and enhance interactivity and engagement, thereby effectively promoting deep learning (Matthews and Volpe, 2023).

In summary, existing literature has examined the mechanisms influencing deep learning from multiple dimensions, including teacher roles, teaching methods, learning environments, and digital technologies. However, relatively few studies have analyzed the mechanisms through which deep learning occurs specifically in the context of higher vocational education. Moreover, although GenAI is increasingly becoming an "intelligent partner" in classroom settings (Al-Ali and Tlili et al., 2024), current discussions of deep learning behaviors have not sufficiently addressed the role and impact of GenAI.

2.2. Applications of GenAI in Education

GenAI tools are becoming deeply embedded in and profoundly reshaping the instructional models and application boundaries of vocational education (Qin and Liu et al., 2023). As the technology continues to evolve, the role of GenAI in vocational education has become increasingly prominent, driving innovation in teaching methods.

Leveraging advanced intelligent models, GenAI can offer personalized learning plans for students. By analyzing learners' progress, interests, and cognitive abilities, it is able to generate customized learning pathways (Noy and Zhang, 2023). Owing to its high scalability and adaptability, GenAI also enables instructors to dynamically adjust teaching strategies based on real-time data, thereby better meeting the individualized needs of students. Furthermore, GenAI plays an important role in monitoring and assessing student learning. Through automated assessments, GenAI can continuously track learners' progress, identify weaknesses in their knowledge mastery, and optimize the instructional process by providing adaptive feedback (Barbieri and Nguyen, 2025).

In terms of learning paradigm transformation, GenAI fosters enhanced interaction between technology and human participants. The synergistic collaboration between humans and intelligent systems strengthens immersion in teaching, enabling students to gain more vivid learning experiences through virtual environments (Wang and Huang, 2025). Moreover, GenAI demonstrates significant advantages in optimizing instructional environments and constructing intelligent learning spaces. By integrating real-world instructional scenarios with virtual simulation environments, GenAI provides more flexible and efficient modes of teaching for vocational education. For example, through virtual reality (VR) and augmented reality (AR) technologies, students can experience workplace scenarios immersively and engage in hands-on practice (Matthews and Volpe, 2023).

At the same time, researchers have noted that while GenAI offers considerable convenience, it also introduces ethical challenges and governance risks (Levin and Marom et al., 2025). For instance, as information overload intensifies, students may experience difficulties discerning the credibility of automatically generated content, which exacerbates tendencies toward superficial learning. In addition, students may become overly dependent on AI-generated responses, resulting in reduced deep thinking and critical analysis, thus negatively affecting their capacity for deep learning.

In sum, although the transformative potential of GenAI for the future of education is indisputable, further investigation is needed to understand how GenAI can substantively support students' deep learning within technology-embedded learning environments, as well as to address the new challenges, emerging issues, and evolving expectations that students encounter in the learning process.

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3. Activity Theory

Activity Theory, originally developed by Vygotsky, Leontev, and other scholars, was later expanded by Engeström into the well-known "triangular model" (Bakhurst, 2009; Engeström, 2014). Within this model, human activity is understood not as an isolated behavior but as situated within a sociocultural system composed of subject, object, tools, community, rules and division of labor. Learning and development emerge through the dynamic interactions among these elements. Activity Theory has thus been widely applied to investigate educational and instructional practices in technology-integrated environments.

Building on Activity Theory, Qin et al. (2023) examined the mechanisms through which instructional activities unfold when artificial intelligence is embedded in teaching, and further delineated the six key elements of instructional activity as follows: Subject, referring to participants in the learning process, including teachers, students, and the newly emerging "AI-based quasi-subjects"; Object, denoting the goals and tasks of learning, which may encompass multidimensional objectives such as knowledge acquisition, competency development, skills, emotions, and values; Tools, representing the mediating artifacts used in learning, including textbooks, technological tools, GenAI applications, and domain-specific AI models; Community, referring to the collective formed around shared learning goals, such as teacher–student, student–student, and teacher–AI–student configurations; Rules, encompassing the institutional and normative frameworks that regulate learning behaviors, including assessment systems, guidelines for technology use, academic integrity policies, and privacy regulations; and Division of Labor, describing the distribution of roles and responsibilities within the learning community, for example, teachers focusing on pedagogical guidance, AI undertaking routine or foundational tasks, and students maintaining active engagement in the learning process.

Table 1. Fundamental Components of Activity Theory in Educational Practice

Elements	Manifestation in Teaching
Subject	Participants in the teaching and learning process
Object	Learning goals and tasks
Tools	Mediating artifacts used in learning
Community	Groups formed around shared learning goals
Rules	Institutional norms regulating learning behaviors
Division of Labor	Allocation of responsibilities among members of the community

At the same time, Activity Theory posits that individual learning behavior is jointly driven by four interrelated subsystems, which elucidate the operational logic of learning activities at different levels. The production subsystem focuses on the process through which subjects utilize tools to act upon learning objectives, thereby reflecting the mechanisms of knowledge construction and capacity development. The communication subsystem emphasizes the interactions between subjects and the learning community under the constraints of rules. Through communication, collaboration, and feedback, this subsystem facilitates the deepening of knowledge. The consumption subsystem concerns the temporal, emotional, and cognitive resources invested by subjects within various communities to achieve learning goals, highlighting the contextual and affective dimensions that support learning. The distribution subsystem addresses the allocation of tasks and responsibilities within the community, determining how roles are divided among teachers, students, and AI systems, which in turn shapes the efficiency and depth of learning. Collectively, these four subsystems constitute a dynamic learning ecology that explains how learning activities unfold through the interplay of technological, social, and cognitive dimensions.

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4. Impact of GenAI on Deep Learning among Higher Vocational Students

As GenAI becomes deeply embedded in instructional processes, the resulting transformation of learning has extended far beyond the technological replacement of tools (Yan and Greiff et al., 2024). Rather, GenAI exerts systematic influence on learners' cognitive processing, interactional structures, emotional engagement pathways, and the distribution of instructional roles. Activity Theory posits that learning activities are constituted through the dynamic interplay of subjects, objects, tools, rules, community, and division of labor, and its four interrelated subsystems reveal the underlying logic through which instructional activities operate. This framework provides a robust analytical lens for examining behavioral changes in learning when technology is integrated into educational environments. Accordingly, the present study adopts the four-subsystem perspective to analyze how GenAI fosters the emergence of deep learning among higher vocational students.

First, within the production subsystem, GenAI supports deep learning by providing instant explanations, generating examples, and presenting content at multiple levels of complexity, thereby constructing individualized knowledge frameworks for learners. This helps vocational students overcome barriers to understanding and shifts their learning from mechanical reception to deep cognitive processing. Meanwhile, GenAI can simulate authentic vocational scenarios, generate cross-situational tasks, offer comparative solutions, and facilitate practice-based reasoning (Wang and Huang, 2025). Through iterative trial, exploration, and instant feedback, students develop transferable understanding and complex problem-solving abilities—capacities that are especially crucial in practice-oriented vocational education. Moreover, AI transforms the teacher's role from a traditional transmitter of knowledge into a designer of deep learning experiences, allowing teachers to devote more effort to constructing challenging tasks, guiding reflective dialogue, and supporting students' higher-order thinking (Kim and Lee et al., 2022). This shift moves instruction from "teaching the textbook" toward "teaching thinking and competence," thereby significantly advancing the attainment of deep learning outcomes.

Second, in the communication subsystem, the dialogic capacity and formative feedback mechanisms of GenAI reconfigure interaction patterns among teachers, students, and intelligent tools (Anderson and Nguyen et al., 2025). GenAI not only expands opportunities for learners to articulate ideas, pose questions, and verify emerging understandings, but also supports diagnostic feedback and guided prompts that deepen cognitive engagement. As a result, learning interactions shift from surface-level correct/incorrect exchanges to meaningful, understanding-oriented dialogue (Chukwuedo and Mbagwu et al., 2021). In vocational education contexts, such enhanced interaction is particularly conducive to the development of students' metacognitive awareness, enabling them to continuously monitor, adjust, and optimize their learning processes.

Third, within the consumption subsystem, the integration of GenAI fosters collaborative functioning among multiple learning communities, thereby forming a network of emotional, social, and cognitive resources that support deep learning. The human–AI community provides stable cognitive support and emotional companionship, reducing frustration in tackling challenging tasks (Kim and Lee et al., 2022). The teacher–student community strengthens cognitive guidance and value formation. And the student–student community, enhanced by AI, enables more effective collaborative inquiry. From the perspective of resource investment, these communities collectively enhance students' sustained engagement in complex tasks, imbuing deep learning with contextual, emotional, and continuous characteristics.

Finally, in the distribution subsystem, GenAI reshapes the structure of instructional roles and facilitates more rational and efficient forms of human–AI collaboration. AI undertakes foundational and procedural tasks—such as information consolidation, text generation, and

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preliminary analysis. This allows students to allocate more cognitive resources to higher-order thinking, problem-solving, and innovation (Kim and Lee et al., 2022). Meanwhile, teachers assume an enhanced role emphasizing cognitive guidance, value orientation, and individualized support, reinforcing their irreplaceable educational function. Such rational division of labor optimizes the overall efficiency of instructional activities and further ensures the quality and depth of students' learning.

In sum, GenAI operates systematically across the four subsystems—production, communication, consumption, and distribution—collectively forming a dynamic mechanism that supports and enhances deep learning among higher vocational students.

5. Conclusion

Drawing on Activity Theory, this study reveals that GenAI reshapes vocational students' deep learning through four subsystems. GenAI strengthens cognitive support, enhances interaction quality, enriches emotional and social resources, and enables more effective human–AI division of labor. While GenAI provides new opportunities for deep learning, risks such as over-reliance and weakened critical thinking still require attention.

This study makes several theoretical contributions. First, existing research seldom addresses deep learning considering the unique characteristics of higher vocational students. This study constructs a four-subsystem mechanism model that elucidates how deep learning emerges in GenAI-supported vocational contexts. Second, the findings provide theoretical grounding for constructing teacher–student–AI collaborative learning communities, offering a conceptual basis for future research on intelligent vocational education models.

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References

[1] Al-Ali, S. and A. Tlili, et al. (2024). "LAIK your classroom: A practical framework to integrate generative AI in higher education classrooms." Journal of Applied Learning and Teaching 7(2).

[2] Anderson, J. E. and C. A. Nguyen, et al. (2025). "Generative AI-driven personalization of the Community of Inquiry model: enhancing individualized learning experiences in digital classrooms." The International Journal of Information and Learning Technology 42(3): 296-310.

[3] Bakhurst, D. (2009). "Reflections on activity theory." Educational review 61(2): 197-210.

[4] Barbieri, W. and N. N. Nguyen (2025). "Generative AI as a placement buddy: Supporting pre-service teachers in work-integrated learning, self-management and crisis resolution." Australasian Journal of Educational Technology 41(2): 34-49.

[5] Biggs, J. (1999). "What the student does: Teaching for enhanced learning." Higher education research & development 18(1): 57-75.

[6] Chaudhary, P. and R. K. Singh (2025). "The deep approach to learning as a measure of quality education in accreditation." Quality Assurance in Education.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202512_8(12).0047

[7] Chukwuedo, S. O. and F. O. Mbagwu, et al. (2021). "Motivating academic engagement and lifelong learning among vocational and adult education students via self-direction in learning." Learning and Motivation 74: 101729.

[8] Engeström, Yrjö. (2014). Learning by expanding: An activity-theoretical approach to developmental research, Cambridge University Press.

[9] Huang, F. (2025). "Exploring a new model of undergraduate vocational education." Vocation, Technology & Education 2(1).

[10] Kim, J. and H. Lee, et al. (2022). "Learning design to support student-AI collaboration: Perspectives of leading teachers for AI in education." Education and information technologies 27(5): 6069-6104.

[11] Levin, I. and M. Marom, et al. (2025). "Rethinking AI in Education: Highlighting the Metacognitive Challenge." BRAIN. Broad Research in Artificial Intelligence and Neuroscience 16(1 Sup1): 250-263.

[12] Matthews, J. and C. R. Volpe (2023). "Academics' perceptions of ChatGPT-generated written outputs: A practical application of Turing's Imitation Game." Australasian Journal of Educational Technology 39(5): 82-100.

[13] Noy, S. and W. Zhang (2023). "Experimental evidence on the productivity effects of generative artificial intelligence." Science 381(6654): 187-192.

[14] Qin, Y. C. and G. P. Liu, et al. (2023). "How Generative AI Reshapes Teaching Activities——Model Construction and Application Based on Activity Theory." Distance education in China 43(12): 34-45.

[15] Rajaram, K. (2023). Future of learning: Teaching and learning strategies. Learning Intelligence: Innovative and Digital Transformative Learning Strategies: Cultural and Social Engineering Perspectives, Springer: 3-53.

[16] Rusticus, S. A. and T. Pashootan, et al. (2023). "What are the key elements of a positive learning environment? Perspectives from students and faculty." Learning environments research 26(1): 161-175.

[17] Song, X. and X. Yang, et al. (2022). "The relationship between teacher's gender and deep learning strategy: the mediating role of deep learning motivation." Psychology in the Schools 59(11): 2251-2266.

[18] Wu, X. (2024). "Exploring the effects of digital technology on deep learning: a meta-analysis." Education and Information Technologies 29(1): 425-458.

[19] Yan, L. and S. Greiff, et al. (2024). "Promises and challenges of generative artificial intelligence for human learning." Nature Human Behaviour 8(10): 1839-1850.