ISSN 2522-6398 Vol. 9, Issue 5: 168-173, DOI: 10.25236/FER.2026.090523

Obstacle Factors Diagnosis of Generative AI Literacy in Higher Education

Liyun Zhu[1,*], Liying Zhu[2], Shi Yin[3], Yu Deng[1], Weifang Zhong[4]

[1]*College of Economics and Management, Hebei Agricultural University, Baoding, Hebei, 071000, China*
[2]*College of Agronomy, Hebei Agricultural University, Baoding, China*
[3]*College of Humanities and Social Sciences, Hebei Agricultural University, Baoding, Hebei, 071000, China*
[4]*College of Ocean, Hebei Agricultural University, Qinhuangdao, Hebei, 066003, China*
**Corresponding author*

Abstract: *In the era of generative artificial intelligence (GenAI), cultivating university students' GenAI literacy has become imperative for promoting the digital transformation of higher education. Despite growing recognition of its importance, systematic assessment frameworks and empirical evidence regarding students' GenAI literacy remain underdeveloped. This study develops a comprehensive five-dimensional GenAI literacy framework encompassing Knowledge and Understanding (KU), Usage and Application (UA), Assessment and Creation (AC), Usage Attitudes (AT), and Usage Ethics (UE). Survey data from 482 Chinese university students are analyzed using obstacle factor diagnosis. The findings reveal that knowledge and understand dimension constitutes the primary bottleneck, with its three indicators exhibiting the highest obstacle degrees. Additionally, core obstacles evolve as literacy levels advance. Low-level groups face knowledge and attitude barriers, medium-level groups struggle with knowledge depth, high-level groups require enhanced assessment and creation abilities. Based on these findings, a five-stage improvement pathway is proposed: Knowledge Foundation → Attitude Guidance → Ethics Safeguard → Application Implementation → Creative Elevation, providing evidence-based guidance for curriculum design.*

Keywords: *Generative Artificial Intelligence; Literacy; Higher Education; Obstacle Factors*

1. Introduction

Artificial intelligence (AI) is increasingly permeating daily life and is being progressively adopted across a range of professional domains, including education [1-2], healthcare [3], and marketing [4-5]. As a foundational competency, AI literacy has become essential across industries. In the context of higher education, AI has extensive applications in areas such as assessment and evaluation, adaptive learning systems, personalized education, and intelligent tutoring systems. It is therefore essential for students to develop the skills to use AI responsibly and to discern between ethical and unethical applications. At the same time, further investigation into ethical frameworks and pedagogical strategies for AI education in university settings is imperative [6].

In recent years, the emergence of Generative AI (GenAI), most notably represented by ChatGPT, has attracted substantial attention due to its advanced capabilities and extensive applications [7]. With its user-friendly interface and the fact that users do not require specialized AI knowledge or programming skills, GenAI tools have rapidly permeated university students' academic and personal lives, consequently elevating the imperative for GenAI literacy. The rapid advancement of GenAI has fundamentally reshaped the educational landscape, introducing both profound opportunities and considerable challenges. Extant literature has examined ChatGPT's applications, limitations, and future directions [8-9], as well as broader GenAI trends [10]. Alongside its multifaceted impacts on education [11-12], GenAI demonstrates a strong capacity to extract information from unstructured data sources, such as raw text, images, audio, and video, thereby generating more coherent and contextually accurate text [13]. This functionality supports educators in developing lesson plans, presentations, and exam materials, while simultaneously assisting students in personalized learning, writing, and brainstorming. It also holds potential for enhancing research and analytical skills [14]. As a useful tool for learning, teaching, and assessment, GenAI has yielded promising results in practical educational applications [15].

ISSN 2522-6398 Vol. 9, Issue 5: 168-173, DOI: 10.25236/FER.2026.090523

2. Construction of GenAI literacy assessment framework

Ng et al. [16] conceptualized AI literacy abilities based on Bloom's taxonomy into knowing and understanding, using and applying, evaluating and creating, and AI ethics. Wilson et al. [17] proposed an ICT framework called KSAVE, which stands for knowledge, skills, attitudes, values, and ethics. Based on the AI literacy elements from the above studies, a five-dimensional GenAI literacy assessment framework is constructed.

2.1 GenAI knowledge and understanding (KU)

Knowledge and Understanding (KU) encompasses declarative knowledge and factual information required for foundational comprehension of GenAI. This dimension comprises three indicators: understanding GenAI concepts and operational principles (KU1), the ability to distinguish between intelligent devices and conventional devices (KU2), and awareness of GenAI tool functions (KU3). Students are expected to demonstrate familiarity with the applications, advantages, and disadvantages of various prevalent GenAI tools, such as ChatGPT, Wenxin Yiyan, Doubao, Kimi, and so on.

2.2 GenAI use and applications (UA)

Utilization competence refers to the ability to apply GenAI knowledge, concepts, and applications in different contexts. Specifically, it comprises three sub-dimensions: the ability to select GenAI tools (UA1), proficiency in operating GenAI tools (UA2), and the ability of employing GenAI tools in creative work (UA3). This competence enables students to decide whether and which GenAI tools to use based on the context and the performance of the tools. With proficient application, they can skillfully leverage GenAI tools to access the needed information, solve problems and improve learning and work efficiency. Most importantly, they are willing to use GenAI to develop intelligent and innovative content.

2.3 GenAI assessment and creation (AC)

Critical thinking competence encompasses higher-order cognitive skills such as assessment, evaluation, prediction, and design in GenAI applications. It comprises three sub-dimensions: the verification of GenAI-sourced information (AC1), the assessment of GenAI capability limitations (AC2), and the ability to collaborate creatively with GenAI (AC3). Students demonstrate this competence with epistemic curiosity toward GenAI outputs and prompt further inquiry. They also know clearly how to verify the reliability of GenAI-generated content and can identify the most appropriate option from the multiple solution. Over time, students become capable of evaluating the strengths and limitations of the current GenAI tools. Furthermore, they can communicate and collaborate effectively with GenAI to carry out higher-order creative activities such as prediction and design.

2.4 GenAI usage attitudes (AT)

Usage Attitudes collectively reflect an individual's behaviors and emotions regarding the knowledge and skills they possess. It comprises five sub-dimensions: Positive attitude toward GenAI technology (AT1), i.e. students view GenAI as exciting and promising, demonstrate a willingness to trust its capacity to provide unique insights, perspectives, and personalized information. The importance awareness of the GenAI (AT2), reflecting the degree to which students perceive GenAI as vital to their academic and daily lives. Risk perception in GenAI use (AT3), which involves the awareness of potential harms such as data privacy, information security, legal issues, and over-reliance risks. Recognition of GenAI-generated misinformation (AT4), referring to students' ability to understand that GenAI may produces factually inaccurate, decontextualized, or inappropriate content. Awareness of bias in GenAI content (AT5), encompassing their acknowledgment that content generated by GenAI may exhibit potential prejudice and unfairness.

2.5 GenAI usage ethics (UE)

This dimension centers on human-centered considerations in the use of GenAI, including fairness, accountability, transparency, ethics, and safety. Specifically, it comprises three sub-dimensions: Compliance behavior with GenAI ethics (UE1) reflects students' adherence to privacy protection and

ISSN 2522-6398 Vol. 9, Issue 5: 168-173, DOI: 10.25236/FER.2026.090523

ethical guidelines when using GenAI. Awareness of GenAI abuse (UE2) refers to their vigilance in recognizing and preventing the potential GenAI abuse and malicious applications of GenAI technologies. Recognition of the importance of GenAI ethics (UE3) captures their recognition of GenAI ethics as foundational to the sustainable development of GenAI. Students demonstrate this competence consistently maintain awareness of potential misuse, uphold privacy rights, and insist on compliance with ethical and legal standards. They are firmly convinced that ethical considerations are not merely supplementary but essential to the advancement of GenAI.

3. Obstacle factor diagnostic method

Step 1, defining the indicator deviation degree: $L_j = 1 - T_{kj}$

where L_j represents the gap between the j_{th} indicator and the ideal target, and T_{kj} is the standardized value of the j_{th} indicator in the k_{th} dimension.

Step 2, defining the indicator obstacle degree: $H_{kj} = W_j L_j / \sum_{j=1}^{n} W_j L_j$

where n represents the total number of specific indicators. H_{kj} represents the obstacle degree of a particular indicator in the k_{th} dimension. The higher the obstacle degree, the greater the hindrance to the development of higher education GenAI literacy, and the more attention it requires.

Step 3, measuring the obstacle degree of each dimension to the development of higher education GenAI literacy: $Y_k = \sum_{j=1}^{n} H_{kj}$. Where Y_k represents the impact of the k_{th} dimension on GenAI literacy.

4. Results and analysis

4.1 Sample characteristics statistics results

A total of 482 voluntary participants were recruited from a Chinese university. Research data were collected through structured questionnaires. The questionnaire consisted of 17 items, including 5 measurement dimensions, i.e., GenAI knowledge and understanding (KU), GenAI use and applications (UA), GenAI assessment and creation (AC), GenAI usage attitudes (AT), GenAI usage ethics (UE). All items were measured using a 5-point Likert scale, with the ends of the scale representing 1 (strongly disagree) and 5 (strongly agree). Table 1 presented the demographic characteristics of participants, including gender, educational level and major distribution. The number of female respondents was about 1.8 times the number of male respondents. Academically, undergraduates formed the majority, with a smaller proportion of master's students, and doctoral students represented only a minimal supplementary component. This reflected that the sample was predominantly drawn from lower-level higher education. Disciplinary coverage included humanities, sciences, engineering, and agriculture. Humanities dominated at 51.0%, while the remaining three fields were represented in smaller proportions.

Table 1 Sample characteristics statistics results

Characteristics variables	Item	Frequency (N)	Percentage (%)
Gender	male	172	35.685
	female	310	64.315
Year of study	undergraduate study	376	78.008
	Master study	97	20.124
	doctoral study	9	1.867
major	Liberal Arts	246	51.037
	Science	98	20.332
	Engineering	67	13.900
	Agriculture	71	14.730

4.2 Diagnostic analysis of GenAI literacy level impairment factors

To further identify the core bottlenecks constraining GenAI literacy, this study used the obstacle model to measure and rank the obstacles across 5 primary dimensions and 17 indicators.

ISSN 2522-6398 Vol. 9, Issue 5: 168-173, DOI: 10.25236/FER.2026.090523

4.2.1 Dimensional obstacle factors

As shown in Figure1, the obstacle degrees varied substantially across dimensions: Knowledge and Understanding (27.12%) > Usage Attitude (25.11%) > Usage and application (16.66%) > evaluation and creation (15.58%) > Usage dimension (14.07%). Therefore, the knowledge and understanding dimension was the main shortcoming in college students' GAI literacy. This indicated that foundational knowledge deficits constituted the foremost barrier to college students' GenAI literacy. Consequently, it was essential to enhance GenAI knowledge learning and training, as well as improved talent training supply-demand coordination and regional coordination.

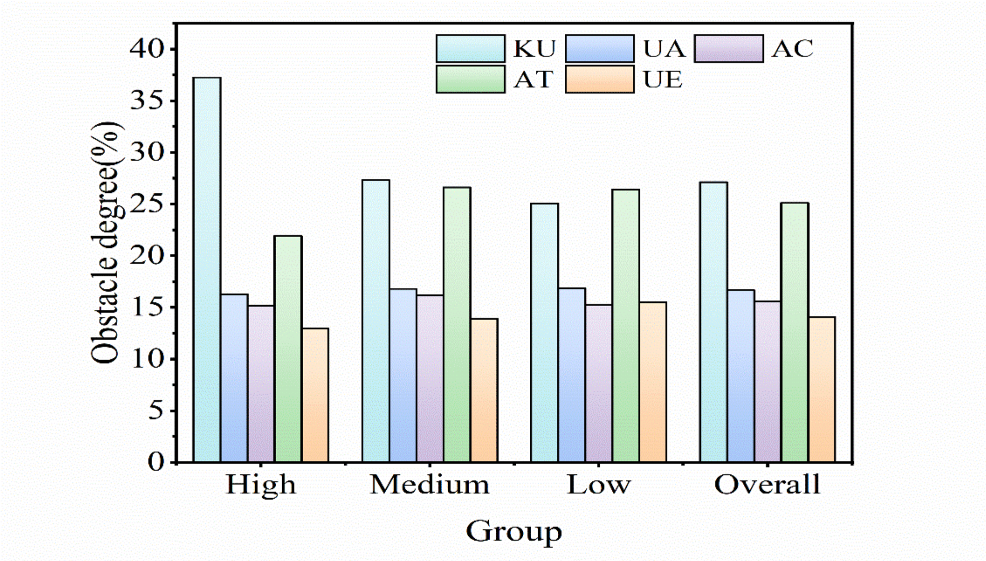

Figure 1 Dimensional Impairment Comparison at High, Medium, Low GAI Literacy Levels

For high-literacy group, the main obstacles were ranked as follows: Knowledge and Understanding (KU) > Usage Attitude (AT) > Usage and Application (UA). This indicated that knowledge barriers were the most prominent, attitude barriers were relatively low, and application barriers were the smallest. High-scoring groups had a deeper understanding of GenAI, making them more aware of their own knowledge gaps, driving elevated standards and continued learning motivation. For moderate-literacy group, the main obstacles were also ranked as follows: Knowledge and Understanding (KU) > Usage Attitude (AT) > Usage and Application (UA). However, given the minimal gap between knowledge barriers (27.30%) and attitude barriers (26.61%), the medium-literacy group faced dual cognitive-affective constraints. Notably, the medium-literacy group exhibited the highest attitude obstacle degree across all three groups, possibly due to feelings of unfamiliarity, distrust, or anxiety toward GenAI. For low-literacy group, attitude barriers were the highest, with both knowledge and practical experience being insufficient. Ethical barriers were the highest among the three groups and the most prominent weakness of the low-score group, indicating that this group lacks ethical awareness the most and may be more likely to overlook issues such as privacy, bias, and responsibility when using GenAI.

4.2.2 Indicator-level obstacle factors

In order to thoroughly explore the critical obstacle factors constraining university students' GenAI literacy level, this study ranked 17 indicators by obstacle degree and selected the top five as primary barriers, as shown in Figure2. Notably, the first three indicators belong to the Knowledge and Understanding dimension, i.e. a good understanding of basic concepts, work principles and uses, understanding the strengths and weaknesses of common GenAI tools, being able to differentiate between intelligent and non-intelligent devices, with the obstacle degree of 10.88%, 8.47%, 7.76%. Therefore, the cumulative contribution of factor impairments in GenAI knowledge and understanding dimension is the greatest. The fourth indicator is the operational proficiency in using GenAI tools to improve learning and work efficiency. The fifth indicator is being alert to the misuse of generative AI, confirming ethical awareness gaps constitute the predominant barriers.

ISSN 2522-6398 Vol. 9, Issue 5: 168-173, DOI: 10.25236/FER.2026.090523

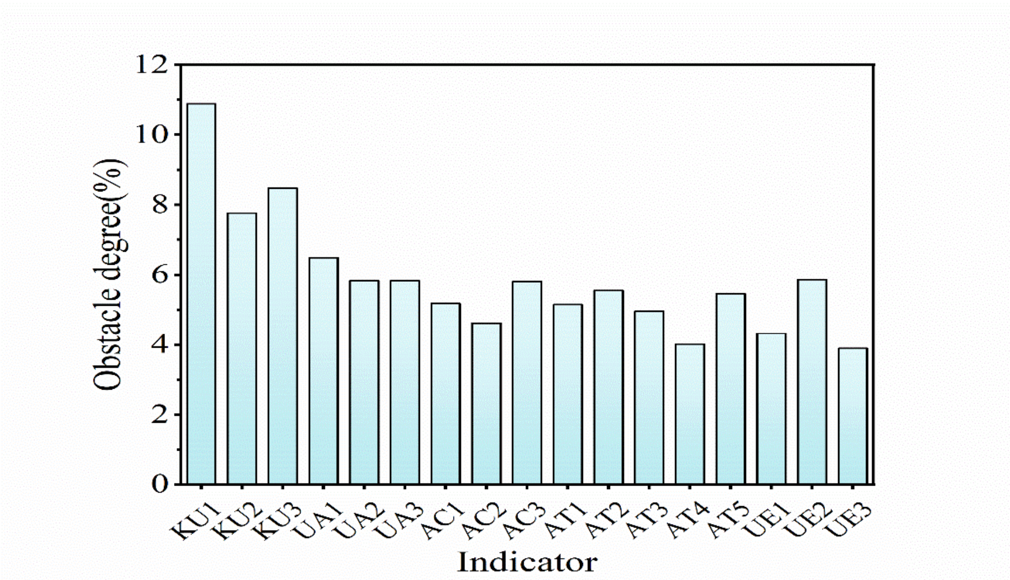

Figure 2 Indicator Layer Obstacle Degree Ranking

5. Conclusion and practical implications

Diagnostic barriers reveal a clear intervention hierarchy: knowledge foundation → attitude guidance → ethical assurance → practical application → creative elevation. Knowledge and Understanding (KU) dimension is the crucial breakthrough with cascading effects across all dimensions, and therefore should be the primary focus of educational reform. Usage attitude (AT) and usage ethics (UE) function as dual value anchors. Usage and application (UA) act as a bridge for the externalization of abilities. Assessment and creation (AC) represent the destination for literacy elevation. Furthermore, students with different literacy levels and varying disciplinary backgrounds should receive stratified and categorized precise teaching interventions to achieve optimal allocation of limited resources.

For educational administrators, these findings furnish empirical grounding for designing an educational curriculum system of GenAI literacy. Considering that knowledge and understanding (KU) is currently the primary bottleneck restricting the improvement of students' GenAI literacy, and that the KU1, KU2, and KU3 indicators rank as the top three in terms of obstacle degree, it is essential to prioritize education in the foundational GenAI principles. Core compulsory offerings such as Introduction to Artificial Intelligence, Algorithmic Principles and Logic, and History of AI Technology Development would ensure that students acquire a solid knowledge foundation and operational comprehension. Concurrently, differentiated instruction should follow proficiency levels: attitude cultivation and knowledge dissemination for low-literacy group, knowledge consolidation and application extension for intermediate learners, and creative evaluation and frontier exploration for advanced students.

For instructors, the five-dimensional evaluation framework and 17 specific indicators constructed in this study furnish diagnostic instruments for assessing university students' GenAI literacy. Regular assessments enable the longitudinal tracking of GenAI literacy development, evaluation of the educational interventions effectiveness, and data-informed curricular adjustments. In particular, the barrier analysis method can assist educators identify critical leverage points, and achieve optimal allocation of limited resources.

Acknowledgment

Funded Projects: Research and Practice Project on Innovation and Entrepreneurship Education and Teaching Reform in Colleges and Universities of Hebei Province (2025cxcy329); The 9th Batch of Scientific Research Projects in Education and Teaching by the Chinese Society of Agronomy (PCE2427); The 12th Batch of Teaching Research Projects of Hebei Agricultural University (202328; 202355)

ISSN 2522-6398 Vol. 9, Issue 5: 168-173, DOI: 10.25236/FER.2026.090523

References

[1] Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. Computers & Education: Artificial Intelligence, 1(3), 100002

[2] Hwang, G. J., Xie, H., Wah, B. W., & Gaˇsevi´c, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. Computers & Education: Artificial Intelligence, 1, 100001.

[3] Matheny, M. E., Whicher, D., & Israni, T. S. (2020). Artificial intelligence in health care: A report from the national academy of medicine. The Journal of the American Medical Association, 323(6), 509-510.

[4] Vlaˇci´c, B., Corbo, L., Costa e Silva, S., & Dabi´c, M. (2021). The evolving role of artificial intelligence in marketing: A review and research agenda. Journal of Business Research, 128, 187-203.

[5] Verma, S., Sharma, R., Deb, S., & Maitra, D. (2021). Artificial intelligence in marketing: Systematic review and future research direction. International Journal of Information Management Data Insights, 1(1), 100002.

[6] Zawacki-Richter, O., Mar´ın VI., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators? International Journal of Educational Technology in Higher Education, 16(1), 1-27.

[7] Wu, T. Y., He,S. Z., Liu,J.P., Sun, S.Q., Liu, K., Han,Q.L., & Tang, Y. (2023). A brief overview of ChatGPT: The history, status quo and potential future development. Journal of Automatica Sinica, 10(5), 1122-1136.

[8] Sok, S & Heng, K. (2023). ChatGPT for education and research: A review of benefits and risks. Cambodian Journal of Educational Research, 3(1), 110-121.

[9] Ray, P.P. (2023). ChatGPT: A comprehensive review on background, applications, key challenges, bias, ethics, limitations and future scope. Internet of Things and Cyber-Physical Systems, 3, 121-154.

[10] Preiksaitis, C., & Rose, C. (2023). Opportunities, Challenges, and Future Directions of Generative Artificial Intelligence in Medical Education: Scoping Review. JMIR Medical Education, 9, e48785.

[11] Baidoo-Anu, D., &Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. Journal of AI, 7(1), 52-62.

[12] Kohnke, L., Moorhouse, B. L., & Zou, D. (2023). ChatGPT for language teaching and learning. RELC Journal, 542, 537-550.

[13] Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S.,

[14] Chan, C.K.Y., & Hu, W.J. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. International Journal of Educational Technology in Higher Education, 20, 43.

[15] Koh, E., & Doroudi, S. (2023). Learning, teaching, and assessment with generative artificial intelligence: towards a plateau of productivity. Learning: Research and Practice, 9(2), 109-116.

[16] Ng, D.; Chu, S. Motivating students to learn AI through social networking sites: A case study in Hong Kong. Online Learn. 2021, 25, 195–208.

[17] Wilson, M.; Scalise, K.; Gochyyev, P. Rethinking ICT literacy: From computer skills to social network settings. Think. Skills Creat. 2015, 18, 65–80.