Research on the Challenges and Countermeasures of AIGC Empowering Students' Autonomous Learning

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ABSTRACT

"Digitalization of education" represents a critical breakthrough for the high-quality development of education. As a key driver of this transformation, Artificial Intelligence Generated Content (AIGC) has become emerging a new trend in both applications and research within the educational field. Advancing the construction of a strong education system through digital transformation not only offers new perspectives and requirements for teaching but also plays a significant role in influencing students' autonomous learning. This study explores the relationship between students' motivations for employing AIGC and the perceived effectiveness of its use. A survey and face-to-face interviews were conducted with college students, and the data was analysed using SPSS software. The results indicate that students are generally reluctant to employ AIGC tools for autonomous learning, with significant individual differences in how effectively these tools are utilized. These differences are most evident in factors such as learning motivation, usage methods, and learning abilities.

Keywords: *AIGC, Artificial intelligence, Digital education, Autonomous learning theory.*

1. INTRODUCTION

With the rapid advancement of information technology, the education sector is undergoing an unprecedented digital transformation. AIGC, as a crucial tool supporting digital education, is gradually emerging as a driving force in educational reform. AIGC refers to content generated through artificial intelligence technologies that aligns closely with user needs, encompassing formats such as text, images, and audio[1]. The application of AIGC in education has expanded beyond basic content generation to include personalized learning support, intelligent tutoring, and more. The core advantage of AIGC lies in its ability to automatically generate learning materials tailored to students' cognitive levels, learning needs, and progress, thereby enhancing both the efficiency and effectiveness of learning.

Currently, the application of AIGC in the global education sector has made notable progress. International scholars, such as Professor Baker (2023), suggest that AI will play a pivotal role in helping students learn faster and more deeply in the future of education[2]. Similarly, domestic researchers, such as Bai Xuemei et al. (2024), argue that AIGC can effectively promote personalized learning by providing real-time feedback and customized content, thereby enhancing students' motivation and engagement[3].

Platforms like Coursera and Duolingo exemplify the integration of AIGC in online education, where they optimize learning experiences by dynamically adjusting learning pathways and offering personalized recommendations, ultimately improving students' autonomous learning abilities. However, research on AIGC in China remains at an early stage compared to international advancements. Most domestic studies focus on how AIGC supports teaching models and redefines the teacher's role, with relatively little attention paid to the processes through which students utilize AIGC tools for autonomous learning, including aspects such as learning motivation, strategies, and outcomes.

This study employs a mixed-methods approach, combining surveys and interviews, to investigate the utilization of AIGC among university students in Wuhan. A comprehensive questionnaire was designed to explore multiple dimensions, including the frequency and context of AIGC usage, students'

learning motivation, and their cognitive evaluations of AIGC. In addition, an interview protocol was developed to delve deeper into students' experiences with and challenges in employing AIGC tools.

Data analysis of students' willingness to adopt AIGC and its impact on learning outcomes reveals that, while AIGC technology theoretically provides effective support for autonomous learning, its practical application varying results due to individual differences. Many students, hindered by a lack of sufficient AI operational skills or an inability to fully leverage the advantages of AIGC tools, fail to realize the full potential of these technologies for enhancing autonomous learning.

2. METHODOLOGY OF THE EMPIRICAL STUDY

2.1 Questionnaire Survey Method

To investigate the challenges faced by university students in applying AIGC and exploring practical strategies for enabling AIGC to support autonomous learning effectively, an online survey titled "Investigation of Experiences and Challenges in Using AIGC to Empower Autonomous Learning" was developed. The questionnaire was distributed randomly among university students in Wuhan, with the link shared via public platforms such as WeChat Official Accounts and Douban. Participants were informed about the survey's purpose and assured they could withdraw from answering at any time.

The data collection spanned four weeks, yielding 246 responses. After excluding responses completed in less than 100 seconds and those with contradictory answers, 198 valid responses were retained, achieving an effective response rate of 80.48%. The primary respondents were undergraduate students from the 2022 and 2023 cohorts, but there were no restrictions on the participants' gender, major, or other demographic factors.

This non-scale questionnaire adopted a mixed methods research design based on survey results. It comprised 14 questions divided into four sections: First, descriptive statistics of the sample: students' basic demographic information (e.g., major, academic year). Second, usage analysis: covered dimensions such as AIGC usage frequency (e.g., "above 90%," "60%-90%," "30%-60%," "10%-30%," "below 10%," "never used"), application scenarios (e.g., course learning, research activities, academic writing)[4], and motivation for use (e.g., information retrieval, expanding thinking, avoiding effort). Third, skills and competencies evaluation: included assessed operational skills (e.g., "from abstract to concrete," "from concrete to abstract,")[5][6]and evaluation skills (e.g., "direct use," "dialectical use"). Forth, cognitive evaluation: included dimensions such as practicality, risk perception, preference, and the impact of AIGC on learning outcomes[7]. Participants were drawn from various universities in Wuhan across different fields of study.

To ensure the reliability, stability, and predictive validity of the non-scale questionnaire, content validity evaluation was conducted. This involved inviting experts to assess the consistency between the questionnaire items and the intended measurement objectives. Specifically, six educators with expertise in AIGC usage and research were invited to score 16 questionnaire items on a scale from 1 to 4, where higher scores indicated greater validity. The results of this evaluation are summarized in "Table 1".

Table 1. Expert ratings and Content Validity Index (CVI) calculations for measurement items

Measurement Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Experts Rating 3/4	I-CVI	I-CVI Evaluation	Pc	K*	K* Evaluation
1	4	4	4	4	4	3	6	1.000	Pass	0.016	1.000	Excellent
2	4	4	3	4	4	3	6	1.000	Pass	0.016	1.000	Excellent
3	4	3	3	4	3	3	6	1.000	Pass	0.016	1.000	Excellent
4	3	4	3	4	4	4	6	1.000	Pass	0.016	1.000	Excellent
5	4	3	4	3	3	3	6	1.000	Pass	0.016	1.000	Excellent
6	3	4	3	4	4	4	6	1.000	Pass	0.016	1.000	Excellent
7	3	3	4	4	4	4	6	1.000	Pass	0.016	1.000	Excellent
8	4	4	4	4	3		6	1.000	Pass	0.016	1.000	Excellent

Measurement Item	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Experts Rating 3/4	I-CVI	I-CVI Evaluation	Pc	K*	K* Evaluation
9	4	3	3	3	4	4	6	1.000	Pass	0.016	1.000	Excellent
10	3	3	4	4	4	4	6	1.000	Pass	0.016	1.000	Excellent
11	4	3	4	3	3	4	6	1.000	Pass	0.016	1.000	Excellent
12	4	4	3	3	4	4	6	1.000	Pass	0.016	1.000	Excellent
13	3	4	4	3	4	4	6	1.000	Pass	0.016	1.000	Excellent
14	3	3	3	4	4	4	6	1.000	Pass	0.016	1.000	Excellent
Total number of experts = 6, Total number of items = 16, Sum of ratings of 3 or 4 = 96												

A total of 14 measurement items (survey questions) were rated by six educators, resulting in 84 occurrences where the scores given by the experts were either 3 or 4 out of 4. Specifically, the Kappa (K*) values for all 14 measurement items exceeded 0.74, which indicates good agreement.

2.2 Semi-Structured Interview Method

The study used snowball sampling to select six students (designated S1 to S6) from the questionnaire respondents who voluntarily participated in one-on-one interviews. These participants were diverse in gender, grade level, major and academic performance, making their perspectives representative ("Table 2"). The researchers designed the interview outline based on the survey results, focusing on students' experiences using AIGC. The interviews explored issues encountered during use, expectations of AIGC functionalities, and the impact of AIGC on learning habits and thinking patterns. Each interview lasted an average of 23 minutes and was recorded in full.

Table 2. Basic information of interviewed students

ID	Gender	Grade Level	Major	AIGC Usage Frequency
1	Female	2023	Foreign Language	30%-60%
2	Male	2022	Journalism	30%-60%
3	Female	2021	Art & Design	10%-30%
4	Male	2024	Foreign Language	10%-30%
5	Male	2023	Law	Below 10%
6	Female	2022	Computer Science	10%-30%

From September to November 2024, researcher conducted semi-structured interviews with six respondents. The analysis followed the grounded theory method proposed by Strauss and Corbin[8]. The process consisted of three levels of abstraction:

The first is the open coding. Researcher conceptualized and categorized the data based on the research theme. The second is the axial coding. Researcher further merged extracted concepts to identify categories reflecting key functionalities of information technology, educational interactions, and learning outcomes. The third is the selective coding. Researcher aimed to illustrate the process by which the use of key information technology functionalities impacts learning outcomes through a "condition–process–result" logic. The data of six coders were analyzed independently, ensuring saturation and achieving good reliability and validity[9].

2.3 Data Collection Results

Firstly, as shown in "Table 3", in terms of the frequency and starting time of AIGC usage, the survey results indicate that university students generally began utilizing AIGC applications during their college years, specifically starting in 2023. This trend aligns closely with the development trajectory of AIGC technology and the emphasis placed by university education on fostering students' autonomous learning abilities. However, differences in usage frequency were observed among students from various academic disciplines and grade levels. For instance, certain majors, due to the nature of their coursework and learning

demands, reported a relatively higher frequency of AIGC usage. Students majoring in foreign languages, such as participants S1 and S4, noted frequent use of AIGC tools for language learning tasks. One participant stated: "I often use ChatGPT for translation or text analysis. Sometimes, I directly ask it about unfamiliar words." In contrast, students in STEM disciplines expressed that while AIGC aids in tasks such as drafting reports, designing experiments and summarizing theoretical principles, its outputs often require careful review and revision due to occasional inaccuracies or ambiguities.

Table 3. Frequency analysis of the basic situation of college students using AIGC

Dimension	Option	n	Percentage (%)
What's your current academic year	A.2024	12	6.06
	B. 2023	116	58.59
	C. 2022	60	30.30
	D. 2021	10	5.05
When to start using AIGC?	A. During high school	21	10.61
	B. During university	177	89.39
How frequently do you use generative AI in your studies?	A. 90% or more	6	3.03
	B. 60%-90%	33	16.67
	C. 30%-60%	106	53.54
	D. 10%-30%	48	24.24
	E. Less than 10%	5	2.53
	F. Never use	2	1.01
Total		198	100.0

Secondly, students' motivations for using AIGC are diverse in "Figure 1". Most students use AIGC as a platform for information gathering and expanding their thinking, recognizing its value as a learning aid. However, about 35% of students exhibit a tendency to rely on AIGC without deeper thought, either giving up on thinking when encountering difficulties or immediately seeking answers from AIGC. Only about 10% of students actively engage in in-depth autonomous learning, leveraging AIGC as an extension of classroom knowledge.

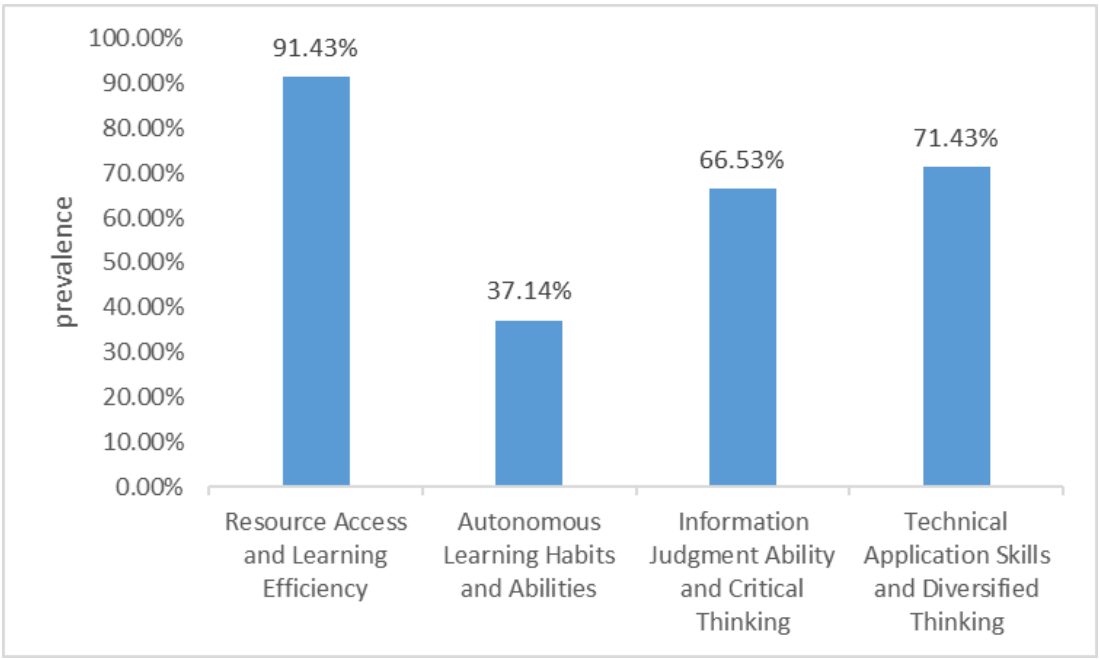

Figure 1 Students' evaluation of the role of AIGC in enabling autonomous learning.

Table 4. Frequency analysis of students' purpose for using AIGC

Labels (Column)	Option	Frequency	Percentage (%)
Purpose of Use	Unwilling to think – Use AI to get immediate results	10	5.05
	Independent thinking unsuccessful – Use AI to get results and stop thinking	59	29.80
	Independent thinking unsuccessful – Use AI to obtain information and continue thinking	109	55.05
	Driven by interest or goals – Use AI to obtain information and study independently	20	10.10
Total		198	100.0

3. RESULTS ANALYSIS AND DISCUSSION

3.1 Analysis of Factors Influencing Usage Intention

Students' intention to use AIGC is influenced by multiple factors. From a technical perspective, the ease of use and functionality of AIGC tools significantly determine students' willingness.

Specifically, the alignment between the output of AIGC and students' expectations has a notable impact on their usage frequency, as shown in "Table 5". When the output aligns well, students tend to use AIGC tools more frequently; conversely, when the output deviates significantly from expectations, usage frequency may decrease. Some students experience a decline in usage intention due to unfamiliarity with the features, operational processes, or effective prompt engineering of AIGC tools, leading to a mismatch between outcomes and psychological expectations.

Furthermore, students' perceptions of AIGC tools play a critical role in shaping their usage intention. If students perceive AIGC tools as beneficial for learning and believe they contribute to academic success, they are more inclined to use them actively. This expectation stems from students' understanding of AIGC functionalities and their judgment of their own learning needs, reflecting a rational evaluation when selecting educational tools.

Table 5. Impact of output alignment frequency on AIGC usage frequency

Title	Labels (Column)	Frequency of Alignment with Expectations				Total	χ^2	p
		Rarely	Occasionally	Frequently	Always			
Usage Frequency of AIGC	≥90%	2 (12.50)	2 (1.80)	1 (1.47)	1 (33.33)	6(3.03)	30.061	0.012*
	60%-90%	4 (25.00)	15 (13.51)	14 (20.59)	0 (0.00)	33(16.67)		
	30%-60%	4 (25.00)	60 (54.05)	41 (60.29)	1 (33.33)	106(53.54)		
	10%-30%	5 (31.25)	30 (27.03)	12 (17.65)	1 (33.33)	48(24.24)		
	<10%	0 (0.00)	3 (2.70)	0 (0.00)	0 (0.00)	3(1.52)		
	Never	1 (6.25)	1 (0.90)	0 (0.00)	0 (0.00)	2(1.01)		
	Total	16	111	68	3	198		

*p<0.05 *p<0.01

A chi-square test (cross-tabulation analysis) was employed to examine the relationship between the frequency of AIGC output meeting expectations and the frequency of AIGC usage in learning. The results indicate a significant relationship (χ^2=30.061, p=0.012<0.05).

For respondents reporting "frequent alignment of AIGC output with expectations," 60.29% used AIGC tools with a frequency of 30%-60%, which is notably higher than the average level of 53.54%. Conversely, for those reporting "rare alignment," 31.25% used AIGC tools with a frequency of 10%-30%, which exceeds the average of 24.24%.

These findings align closely with interview data. For instance, participant S4 stated, "After several uses, I found AIGC tools to be as accurate as conventional dictionary software for word definitions and usage, with the added benefit of

enhanced knowledge extension and systematic organization. As a result, I now use AIGC tools more frequently for word lookup." In contrast, participant S1 mentioned dissatisfaction with AIGC's quality in "English-Chinese translation," citing multiple failed attempts to achieve satisfactory results and ultimately abandoning the tool for this purpose. Hence, the frequency of AIGC output meeting user expectations significantly influence students' usage intentions. Moreover, students' evaluation of the ease of use and functionality completeness of AIGC tools plays a pivotal role in shaping their willingness to use such tools.

3.2 The Relationship Between Learning Motivation and Usage Effectiveness

Learning motivation, as the intrinsic driver of students' learning behaviour, is closely linked to the effectiveness of AIGC usage ("Table 6"). Students learning attitudes largely shape their motivations, which in turn affect their purposes for using AIGC tools. Students who actively seek knowledge expansion and aim to enhance their independent learning abilities are more likely to integrate AIGC tools into their learning processes, fully exploiting their potential and achieving better outcomes. Conversely, students motivated by a desire to avoid cognitive effort often fail to harness the full capabilities of AIGC tools and may even weaken their independent learning skills through overreliance on AIGC-provided answers. Therefore, guiding students toward establishing appropriate learning motivations is crucial for enhancing the effectiveness of AIGC usage.

Table 6. Impact of Usage Purpose on Frequency of Alignment with AIGC Output Expectations

Title	Labels (Column)	Usage Purpose (%)				Total	χ^2	p
		Avoid Thinking - Immediate Results via AI	Limited Thinking - AI Results End Process	Limited Thinking - Information from AI for Further Thinking	Interest-Driven - AI for Information and Deep Learning			
Frequency of Output Alignment	Rarely	1(10.00)	10(16.95)	3(2.75)	2(10.00)	16(8.08)	18.847	0.027*
	Occasionally	5(50.00)	27(45.76)	70(64.22)	9(45.00)	111(56.06)		
	Frequently	3(30.00)	21(35.59)	35(32.11)	9(45.00)	68(34.34)		
	Always	1(10.00)	1(1.69)	1(0.92)	0(0.00)	3(1.52)		
	Total	10	59	109	20	198		

* p<0.05 ** p<0.01

A chi-square test (cross-tabulation analysis) was used to investigate the relationship between "different purposes for using AIGC" and "the frequency of AIGC output meeting expectations." The results show a significant difference (χ^2=18.847, p=0.027<0.05). Students driven by interest or clear goals, who engage in deep learning with AIGC, reported a higher proportion of outcomes aligning with expectations compared to the average.

These findings further confirm the critical role of learning motivation in usage effectiveness and underscore the importance of guiding students to cultivate appropriate motivations to maximize the benefits of AIGC tools.

4. CHALLENGES FACED BY AIGC IN ENABLING STUDENTS' AUTONOMOUS LEARNING

4.1 Technical Challenges

4.1.1 Limitations of AIGC Tools

Despite continuous advancements in AIGC technologies, significant functional limitations remain. When handling specialized knowledge and complex problems, AIGC-generated content may lack accuracy, yielding incomplete or incorrect answers. Furthermore, the personalization capability of AIGC tools is insufficient to cater to diverse learning styles and progress rates, limiting its ability to meet the unique needs of every student.

For instance, in certain specialized courses, the solutions provided by AIGC may fail to achieve the required depth or adapt to the learner's pace, thereby affecting overall learning outcomes.

4.1.2 Challenges in Technical Operation

The complexity of certain AIGC commands poses a barrier for students with limited technical proficiency. Challenges such as difficulty in articulating questions to elicit optimal answers and unfamiliarity with effective prompt design hinder the widespread adoption and application of AIGC tools. Many students fail to fully utilize the functionalities of AIGC due to a lack of operational expertise, which restricts its role in facilitating autonomous learning.

4.2 Constraints from Students' Personal Factors

4.2.1 Differences in Learning Ability

Variations in students' learning abilities influence both their proficiency in using AIGC tools and their capacity to apply AIGC-generated outputs effectively. The accuracy and relevance of AIGC outputs not only depend on the technology itself but also correlate closely with students' skill in utilizing these tools[10]. Research indicates that only 36% of students frequently obtain usable outputs, highlighting significant disparities in AIGC usage capabilities. To address students' lack of understanding in using AIGC, the author investigates their questioning approaches as a starting point.

As shown in "Table 7", when formulating initial questions, the mode of inquiry — be it keywords, full sentences, or multimedia prompts — does not significantly affect the relevance of AIGC outputs. However, other studies suggest that prompt reconstruction strategies, particularly those embedding professional contexts, greatly impact the perceived usefulness of generated content.

Table 7. Influence of initial questioning approach on AIGC output accuracy

Title	Labels (Column)	Approach of Initial Questioning (%)			Total	χ^2	p
		Full Sentence	Keyword	Image/Document			
Frequency of Output Alignment	Rarely	9(6.29)	7(14.29)	0(0.00)	16(8.08)	5.168	0.523
	Occasionally	82(57.34)	26(53.06)	3(50.00)	111(56.06)		
	Frequently	49(34.27)	16(32.65)	3(50.00)	68(34.34)		
	Always	3(2.10)	0(0.00)	0(0.00)	3(1.52)		
	Total	143	49	6	198		

* p<0.05 ** p<0.01

In contrast, the overall strategy during iterative questioning plays a crucial role. Most students (91.92%) refine their inquiries or adopt alternative perspectives, with 76.77% opting for detailed questioning. This aligns with Sodova's theory of "openness and cognitive demand of questions."[5] Meanwhile, 12.12% use progressive question chains to synthesize and generalize, which facilitates the acquisition of comprehensive background knowledge in human-AI interactions[6]. However, a lack of effective questioning strategies remains a barrier for some students, limiting AIGC's utility.

The different learning abilities are also reflected in the various adoption of AIGC outputs. The emergent phenomena of AI hallucination and inaccuracies necessitate higher-order critical thinking for proper interpretation and application of AIGC-generated content. While 94.44% of students exhibit strong critical thinking skills in "Table 8", enabling them to filter and integrate reliable information into their knowledge framework, a subset of students relies solely on surface-level answers without deeper understanding, reducing AIGC's impact on their learning outcomes.

Table 8. Frequency analysis of output utilization and follow-up questioning methods

Category	Option	Frequency	Percentage (%)
Output Utilization	Direct Use	8	4.04
	Critical Evaluation and Selection	187	94.44
	Non-utilization of AI Answers	3	1.52
Follow-up Questioning	Continuing Inquiry	182	91.92
	Lack of Follow-up Methods	16	8.08
Overall Questioning Logic	Refinement of Questions	152	76.77
	Expansion and Narrowing	24	12.12
	Alternative Description	22	11.11
Total	198	100.0	100.0

4.2.2 Adaptability of Learning Methods

Traditional learning habits impede the effective integration of AIGC into students' workflows. Many students merely regard AIGC as a replacement for conventional tools such as search engines or grammar checkers, failing to leverage its advanced capabilities for deeper learning. Additionally, the rapid evolution of AIGC technologies introduces novel questioning techniques, which are often underutilized by students. Coupled with "information overload" and "information disorientation," these challenges disrupt AIGC's alignment with the learning process[11].

4.2.3 Cognitive Evaluation Biases

Students predominantly evaluate AIGC based on its practical utility while underestimating associated risks. Surveys statistics, shown in "Table 9", reveal that 76.26% prioritize pragmatic considerations, such as information retrieval and learning efficiency, whereas only 17% factor in risk-value trade-offs, and a mere 5% acknowledge potential risks like ethical concerns. This cognitive bias could negatively affect their academic and moral development, emphasizing the need for cultivating a comprehensive understanding of AIGC.

Table 9. Students' Attitudes Toward AIGC Products

	Option	Frequency	Percentage (%)
Attitude towards AIGC	Practical Utility	151	76.26
	Risk-Value Trade-offs	35	17.68
	Subjective Preferences	12	6.06
Total		198	100.0

4.3 Deficiencies in Educational Environment and Support Systems

Firstly, the guidance and support provided by schools for the application of AIGC remain insufficient, lacking systematic training and instruction. Curriculum design and teaching activities have not fully incorporated AIGC, resulting in students' limited understanding of its appropriate use and potential risks. For example, some students only became aware of AIGC-related risks because of the emphasis placed by instructors during professional courses. In interviews, students S2 and S3, who had a clearer understanding of AIGC's potential risks, attributed this awareness to their teachers' emphasis on how AI-generated images and ghostwriting could impact the design industry and raise intellectual property issues. However, most students lack clear guidance when using AIGC in various learning scenarios.

To address this situation, universities should strengthen their educational role by prioritizing Artificial Intelligence Literacy Education (AILE) and focusing on cultivating students' AI knowledge and skills alongside advanced thinking abilities. In terms of teaching objectives and curriculum design, academic programs should adjust training goals to enhance students' proficiency in applying intelligent technologies. Regarding personalized teaching, universities should provide targeted technical training for students in different

disciplines, helping them develop a scientific understanding of AI's value. This can be achieved by integrating courses to foster habits and behaviors that utilize AI to solve problems effectively. Furthermore, institutions need to emphasize the importance of adhering to technological ethics and professional standards, ensuring alignment between academic and societal values[12].

Secondly, the current lack of a comprehensive evaluation system to measure AIGC's contribution to students' autonomous learning makes it challenging for schools and teachers to assess its effectiveness. This limitation prevents a clear determination of whether AIGC genuinely promotes students' learning progress and skill enhancement, thereby affecting the adjustment of teaching strategies. Some scholars have addressed this issue by conducting grounded theory analyses, coding, and filtering core literature to develop evaluation metrics tailored to the thematic characteristics of college student groups in China. They have also tackled issues prevalent in domestic research, such as its theoretical focus, lack of diversified validation tools, and limited engagement. By utilizing methods such as gamified assessments and paper-based tests, they have created multifaceted validation questionnaires to gather data effectively. These efforts have led to the development of a dedicated evaluation system for measuring AIGC's contribution to autonomous learning and its impact on usage outcomes. This system will achieve a deep integration of technological innovation with learning practices, thereby facilitating the effective application of AIGC in the educational domain[13].

5. CONCLUSION

This study focuses on the role of AIGC in enabling students' autonomous learning. Through an empirical investigation combining questionnaire surveys and interviews, the research uncovers the complex realities of AIGC applications in this context. Findings reveal that students' willingness to use AIGC is influenced by multiple factors, including technical usability, functionality, and the alignment of output with expectations, as well as their anticipated impact on learning outcomes. This demonstrates that students adopt a rational approach when selecting learning tools. However, current AIGC tools exhibit significant shortcomings in these areas.

In terms of the relationship between learning motivation and usage outcomes, positive learning motivation enhances students' ability to leverage AIGC effectively, while negative motivation may lead to overreliance, thereby undermining their autonomy in learning. This underscores the importance of fostering proper learning motivations among students.

The integration of AIGC into autonomous learning faces several challenges. The first is the technical limitations. AIGC tools exhibit functional constraints, such as inadequate accuracy when dealing with specialized knowledge, insufficient personalization, and complex operations, which hinder effective use by students. The second is the student-specific factors. Variations in students' learning abilities significantly impact the effectiveness of AIGC. These include differences in their ability to utilize AIGC tools and capacity to critically engage with its outputs. While the majority of students demonstrate strong critical thinking skills, some fail to harness AIGC effectively due to limited skills. The third is the adaptability to learning methods. Many students struggle to adapt to new learning models facilitated by AIGC. The gap between students' learning approaches and AIGC's technological advancement, compounded by challenges such as "information overload," hampers its effective use. The forth is the limited cognitive evaluation. Students predominantly focus on the practical benefits of AIGC while overlooking its potential risks. This highlights the need to improve students' information ethics and digital literacy. In terms of educational environment and support systems, institutional support for AIGC remains insufficient, with limited systematic training and curriculum integration. The absence of a robust evaluation framework makes it difficult to assess AIGC's contributions to students' autonomous learning.

The study highlights the potential of AIGC in supporting students' autonomous learning while also identifying critical challenges. It provides empirical evidence from a student-centered perspective to inform the digital transformation of education. These insights help educators and policymakers better understand the current state of AIGC applications and refine educational strategies accordingly. Future research should delve deeper into optimizing AIGC functionalities to accommodate individual differences among students, developing more effective training and guidance methodologies, and establishing a comprehensive evaluation framework. Such efforts would foster the seamless integration of AIGC with

students' autonomous learning processes, thereby enhancing educational quality.

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