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Evaluation of the Influence of Artificial Intelligence on College Students' Learning Based on Group Decision-making Method

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Abstract: The rapid development of artificial intelligence technology is transforming people's lifestyles and work patterns across various fields. In the realm of education, it also exerts an influence on the learning experiences of university students. To comprehend the multifaceted impact of artificial intelligence on university students' learning, this paper collected feedback results from a survey on artificial intelligence. Through statistical analysis and differentiation of survey data, focusing on prioritization, scientificity, operability, and rationality, we identified several evaluation indicators that best reflect the impact of artificial intelligence on university students in this survey. Subsequently, by establishing models based on the data and considering the weights and impact levels of different indicators, we utilized group decision methods to quantitatively assess the most crucial aspects of the influence of artificial intelligence on university students' learning. The analysis results provide a comprehensive evaluation of the potential impact of artificial intelligence learning tools on university students' learning.

1. Introduction

Artificial Intelligence, abbreviated as AI, is a field of new technological science that originated from discussions among scientists such as McCarthy and Minsky during a conference at Dartmouth College in the United States in 1956. The full name of AI is "Artificial Intelligence." It encompasses the theoretical foundations, methods, technologies, and application systems developed for simulating, extending, and expanding human intelligence. AI stands as a manifestation of modern technology and represents the culmination of human wisdom.

In recent years, the application of artificial intelligence in higher education has received widespread attention. Ali and Abdel-Haq (2021) explored the role of AI learning in higher

education through bibliographical analysis [1]. Ouyang et al. (2022) conducted a systematic review of AI applications in online higher education from 2011 to 2020 [2]. Zawacki-Richter et al. (2019) focused on the research of AI applications in higher education, emphasizing the role of educators [3]. Chen et al. (2020) provided a review of AI in the education field [4]. Pedro et al. (2019) discussed the challenges and opportunities for sustainable development of AI in education [5]. Borges et al. (2021) studied the strategic application of AI in the digital era through a systematic literature review [6]. Okonkwo and Ade-Ibijola (2021) systematically reviewed the applications of chatbots in education [7]. Kuleto et al. (2021) explored the opportunities and challenges of AI and machine learning in higher education institutions [8]. Tsai et al. (2020) investigated the trends and barriers of learning analytics in European higher education [9]. Dogan et al. (2023) conducted a systematic review of the use of AI in online learning and distance education processes [10]. These studies provide valuable insights for understanding the impact of AI on higher education.

This paper conducts an analysis and numerical processing of the data obtained from the survey questionnaire. Subsequently, it establishes an evaluation indicator system and analyzes its rationality. Building upon this foundation, a mathematical model is developed to assess the impact of artificial intelligence on university students' learning. Finally, the paper presents an analytical report on the influence of artificial intelligence on university students' learning based on the established model and the processed data from the survey.

2. Models and Methods

2.1. Data Analysis and Numerical Processing

The data in this paper are derived from feedback obtained through survey questionnaires, with a total sample size of 4,605 individuals. The survey questionnaire comprises both single-choice and multiple-choice questions. An example of the survey questionnaire is illustrated in Table 1.

Table 1: Example Section of the Survey Questionnaire

Single-Choice Question Examples:
1. Your Gender A Male B Female 2. Your Major A Arts and Humanities B Science and Engineering C Management D Arts 3. Your Grade Level A Freshman B Sophomore C Junior D Senior 4. Your Personality A Introverted B Extroverted C Mild-mannered D Resolute E Emotional F Other
Multiple-Choice Question Example:
23. What activities do you mainly engage in on the internet? Learning and researching B Browsing news C Sending and receiving emails D Entertainment and gaming E Chatting and making friends F Downloading resources G Online shopping H Other 24. In your opinion, what is the most significant advantage of learning software compared to traditional classroom teaching? Comprehensive practice questions B Ability to review material repeatedly C Comprehensive learning resources

In this paper, options for single-choice questions are encoded using a decimal system according to the rules outlined in Table 2.

Table 2: Single-Choice Question Coding Rules

Choices	A	B	C	D	E	F	G
Coding	1	2	3	4	5	6	7

For multiple-choice questions, this paper adopts a binary encoding method. Each option in a multiple-choice question is treated as a binary bit, with 1 indicating the option is chosen, and 0 indicating it is not chosen. Subsequently, the binary bits for each option are combined in the order of options A to E to form a code segment as the final encoding.

2.2 Building Evaluation Indicator System

We have chosen to select indicators and construct an indicator system from three aspects: the level of understanding, the degree of acceptance, and the level of attention towards artificial intelligence. Additionally, this paper categorizes university students into groups based on academic major, grade level, and personality, aiming to facilitate separate evaluation analyses in the subsequent sections.

2.2.1. Cognitive Level Indicator Selection

The index is constructed to describe college students' cognition of artificial intelligence, which will play a certain role in the evaluation of the impact of artificial intelligence on college students' learning. The higher the cognitive level of college students is, the more likely it is to be inspired by artificial intelligence to improve learning efficiency, so it has a higher priority.

We define the Artificial Intelligence Software Adoption Rate (ARAI) as the proportion of students in a group who choose to use artificial intelligence learning software.

$$ARAI = \frac{Use_{numb}}{All_{numb}} \cdot 100\% \tag{1}$$

Where Use_{numb} represents the number of students in the student group who use artificial intelligence software, and All_{numb} represents the total number of students in the student group.

We define the Artificial Intelligence Adaptation Index (AIAI), which indicates the level of adaptation to artificial intelligence in the educational context among the student group.

$$AIAI = \frac{0.5De_{numb}+0.3Ac_{numb}+0.2Pa_{numb}}{De_{nmmb}+Ac_{numb}+Pa_{numb}+Ot_{numb}} \cdot 100\% \tag{2}$$

We define the Artificial Intelligence Integration Index (AIII), which indicates the degree of integration between students' academic performance and artificial intelligence technology within the student group.

$$AIII = \frac{0.5Te_{numb}+0.3Af_{numb}+0.2Fe_{numb}}{All_{numb}} \cdot 100\% \tag{3}$$

2.2.2. Acceptance Level Indicator Selection

This index is used to describe whether college students are willing to use artificial intelligence learning tools to assist their learning in the future, which will play a certain role in evaluating the impact of artificial intelligence on college students' learning. If college students are more willing to use artificial intelligence learning tools to assist their own learning, then they are more likely to be affected by artificial intelligence on college students' learning and have a stronger priority.

We define the Artificial Intelligence Acceptance Rate (AIAR) as an indication of the level of approval within the student group regarding the use of artificial intelligence software for learning.

$$AIAI = \frac{Ap_{numb}}{All_{numb}} \cdot 100\% \quad (4)$$

We define the Artificial Intelligence Trust Index (AITI) as an indication of the level of trust within the student group regarding AI-assisted learning.

$$AITI = \frac{0.7Bi_{numb}+0.3Ni_{numb}}{All_{numb}} \cdot 100\% \quad (5)$$

We define the Artificial Intelligence Replacement of Teachers Index (AIRT) as an indication of the degree to which the student group accepts the possibility of artificial intelligence replacing the teaching profession.

$$AIRT = \frac{0.7Vl_{numb}+0.3Po_{numb}}{All_{numb}} \cdot 100\% \quad (6)$$

2.2.3. Attention Index Selection

The index is constructed to describe whether college students are willing to pay attention to the information provided by artificial intelligence learning tools, which will play a certain role in evaluating the impact of artificial intelligence on college students' learning. This index reflects college students' interests and expectations in artificial intelligence and network tools, and has a strong priority.

We define the Artificial Intelligence Engagement Index (AIEI) as an indication of the student group's expectations and level of attention to artificial intelligence as a learning tool.

$$AIEI = \frac{0.4Es_{numb}+0.3Cip_{numb}+0.2Sp_{numb}+0.1Dre_{numb}}{All_{numb}} \cdot AITI \quad (7)$$

2.3. Group Decision-Making Method

This paper adopts a group decision-making method. Initially, the entropy weight method is used to assign weights to each indicator. Subsequently, the Analytic Hierarchy Process (AHP) is employed for further weight assignment to the indicators. Finally, the scores for each student are obtained by multiplying the weights assigned in both steps by the corresponding indicator values.

2.3.1. Entropy Weight Method

Firstly, to ensure comparability between different indicators in the same dataset, the datasets in the previous section of this article were normalized separately to eliminate the dimensional differences between the indicators.

$$D'_{ij} = \frac{D_{ij}-\min_k\{D_{kj}\}}{\max_k\{D_{kj}\}-\min_k\{D_{kj}\}} \quad (8)$$

Step1: Build the information probability matrix P = $\{p_{ij}\}_{nm}$, where n is the number of objects, and m is the number of indicators.

$$p_{ij} = \frac{D'_{ij}}{\sum_{k=1}^{n} D'_{kj}} \quad (9)$$

Step2: Calculate the information matrix $\{I_{ij}\}_{nm}$, where n is the number of objects, and m is the number of indicators.

$$I_{ij} = -\ln(p_{ij} + \varepsilon) \quad (10)$$

Step3: Calculate the information entropy vector $\{e_j\}_m$, where m is the number of indicators.

$$e_j = \frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} I_{ij} \quad (11)$$

Step4: Calculate the information utility value vector $\{d_j\}m$, where m is the number of indicators.

$$d_j = 1 - e_j \quad (12)$$

Step5: Calculate the weight w_j for the j_{th} indicator.

$$w_j = \frac{d_j}{\sum_{k=1}^{m} d_k} \quad (13)$$

According to the above formulas, the weights of each indicator in the three datasets are calculated, as shown in Table 3.

Table 3: Weights of Each Indicator in the Three Datasets

	ARAI	AIAI	AIII	AIAR	AITI	AIRT	AIEI
Weights of Each Indicator	0.1444	0.1312	0.1373	0.1531	0.1404	0.1422	0.1515
Weights of Each Indicator	0.1608	0.1336	0.1537	0.112	0.1616	0.1164	0.1618
Weights of Each Indicator	0.1441	0.1416	0.1433	0.1454	0.144	0.1375	0.1441

2.3.2. Analytic Hierarchy Process

Step 1: With the ultimate goal of measuring the impact of artificial intelligence on college students' learning, there are three factors under the goal layer, including the degree of cognition, recognition, and attention to artificial intelligence. The index evaluation system is shown in Figure 1.

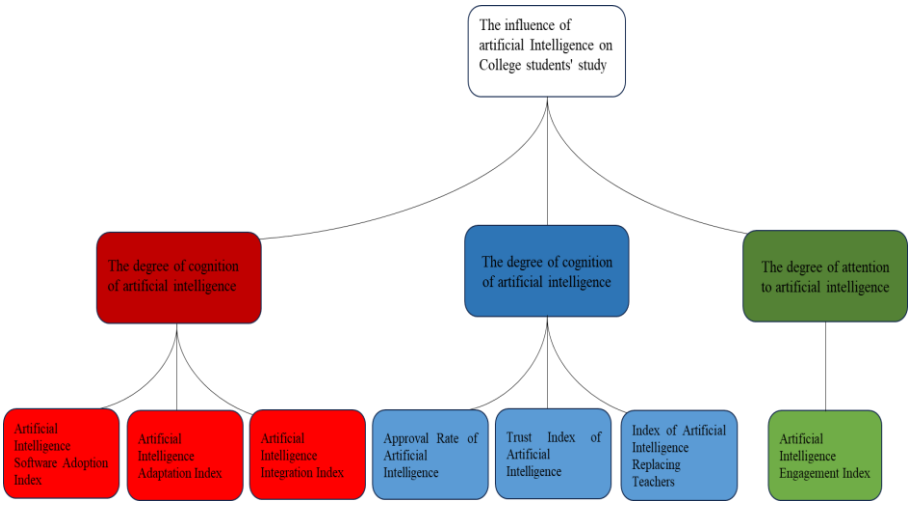

Figure 1: Index evaluation system of analytic hierarchy process

Step 2: Measure the relative importance of each element with respect to the elements in the upper level as the judgment standard. In this paper, based on psychological principles, a scale from 1 to 9 is used to assess the importance of these elements, as shown in Table 4.

Table 4: Importance Level Scale and Meaning

Scale	Meaning
1	Equal importance of x and y to the goal level
3	x is slightly more important than y
5	x is more important than y
7	x is strongly more important than y
9	x is extremely more important than y
2,4,6,8	Intermediate values between adjacent judgments
Reciprocal	Reciprocal If the importance of x compared to y is a, then the importance of y compared to x is 1/a

Based on the significance ranking approach in Table 4, the decision matrices established through the Delphi technique are as follows:

$$M=\begin{pmatrix} 1 & 3 & 3 \\ 1/3 & 1 & 1 \\ 1/3 & 1 & 1 \end{pmatrix}, N_1=\begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}, \quad N_2=1, \quad N_3=\begin{pmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix} \tag{14}$$

Among them, the matrix M refers to the judgment matrix of three indexes in the first layer of factors.

Matrix N1 represents the judgment matrix for Artificial Intelligence Software Popularization Rate (ARAI), Artificial Intelligence Adaptation Index (AIAI), and Artificial Intelligence Integration Index (AIII).

Matrix N2 represents the judgment matrix for Artificial Intelligence Engagement Index (AIEI).

Matrix N3 refers to the judgment matrix for the agreement rate (AIAR), trust index (AITI), and teacher replacement index (AIRT) of artificial intelligence.

Step 3: Using the eigenvalue method (EM) to calculate weights, the maximum eigenvalues and corresponding eigenvectors for each judgment matrix are as follows

$$\lambda_M = 3, Y_M = (0.429, 1.2861.286) \tag{15}$$

$$\lambda_{N_1} = 1, Y_M = (1,1,1) \tag{16}$$

$$\lambda_{N_2} = 1, Y_M = 1 \tag{17}$$

$$\lambda_{N_3} = 1, Y_M = (1,1) \tag{18}$$

Step 4: Consistency Check of Judgment Matrix

Calculate the consistency index, and the average random consistency index data is shown in Table 5.

$$ARAI = \frac{Use_{numb}}{All_{numb}} \cdot 100\% \tag{19}$$

Table 5: Average random consistency index data

Matrix Order	1	2	3	4	5	6
$R.I.$	0	0	0.52	0.89	1.12	1.26

3. Conclusions

3.1. Analysis of Survey Data

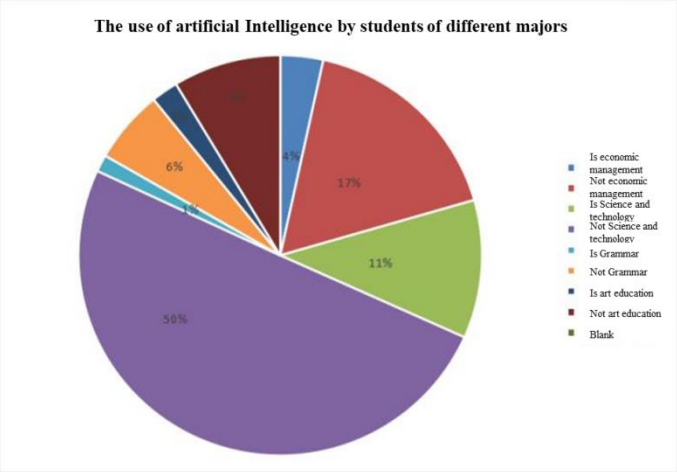

Figure 2: The use of artificial Intelligence by students of different majors

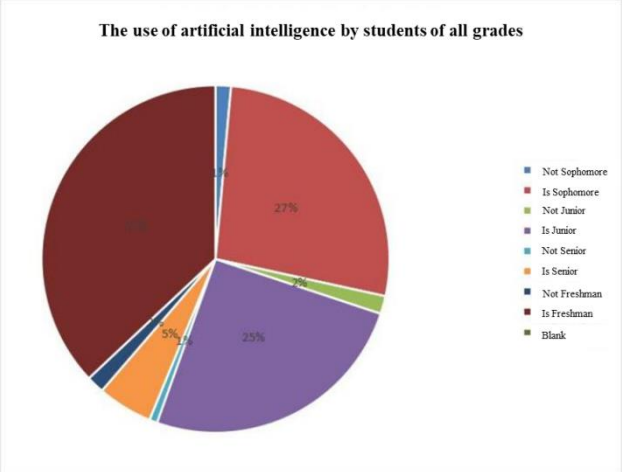

Figure 3: The use of artificial intelligence by students of all grades

We analised of the survey results from various perspectives. Here, we present two examples:

Based on the statistics regarding the use of artificial intelligence by students in different majors, we organized and illustrated the data in a pie chart, as shown in figure 2. Analysis reveals variations in the demand for and application of artificial intelligence across different majors. STEM majors typically have more opportunities to learn and apply AI technology due to their close association with technology.

As depicted in figure 3, students in different grade levels may exhibit variations in their usage of artificial intelligence. Freshman students may not have in-depth exposure to and usage of AI technology yet. They might acquire basic concepts and applications of AI in relevant courses, with relatively limited practical applications. However, there is a higher number of individuals interested in learning about AI. On the other hand, the willingness of seniors (fourth-year students) decreases significantly, possibly due to their imminent graduation. At this stage, they may be more focused on self-directed learning and showcasing their individual capabilities.

3.2. The Evaluation of the Impact of Artificial Intelligence on University Students' Learning

Through the utilization of entropy weighting and analytic hierarchy process (AHP), we have generated evaluations for individual university students. Using this approach, we assess the impact of artificial intelligence on the learning experiences of university students. As an example, we present the average scores for students in different majors, depicted in Figure 4.

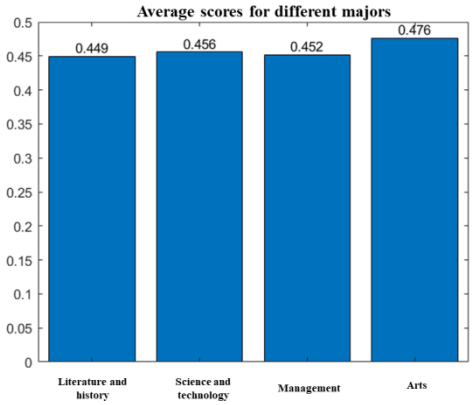

Figure 4: The average score of college students of different majors

Among students in various majors, those in the arts are most affected by the impact of artificial intelligence on university students' learning, followed by students in science and engineering, management, and humanities. We believe this might be attributed to several reasons:

1) Innovation and Creative Assistance: Artificial intelligence holds significant potential in the field of arts, providing innovative and creative assistance to students. For instance, AI can assist artists in generating ideas, offering design suggestions, and creating music and visuals. These technologies broaden the creative horizons and possibilities for students in the arts.

2) Integration of Technology in Artistic Creation: Contemporary art increasingly integrates technological and technical elements, with artificial intelligence playing a crucial role.

3) Promotion and Dissemination of Artwork: AI technology has unique advantages in promoting and disseminating artistic works. Through AI algorithms and platforms, art students can effectively communicate their works to a broader audience, increasing the exposure and influence of their creations.

3.3. The Analysis Report

Based on the data collected from the survey questionnaire and utilizing the models and methods employed, we present an analysis report on the impact of artificial intelligence on university students' learning. The report examines the influence of artificial intelligence on students' learning, taking into consideration both its positive and negative aspects. Through in-depth research and analysis, we conclude that artificial intelligence has a broad impact on university students' learning and possesses significant potential for further development in the future.

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