Intelligent E-learning System Based on Recommendation Algorithm Research on the Psychology of International Students in China under the COVID-19

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Abstract. The study investigates the psychological impacts of the COVID-19 pandemic on international students in China, emphasizing the significant challenges they faced, including depression and anxiety due to quarantine and isolation. It introduces the use of the HES system to analyze students' psychological states and proposes integrating recommendation systems with online questionnaires for effective psychological education strategies. The research aims to fill the gap in understanding international students' mental health during the pandemic and offers insights for improving support systems in educational institutions.

Keywords: International Students in China; psychological impact; COVID-19; intelligent e-learning system

1 Introduction

As higher education increasingly globalizes, actively promoting education for international students in China has multifaceted significance. It facilitates the spread of Chinese culture and values, strengthens international exchanges and cooperation, and enhances the global influence of Chinese education. Therefore, expanding the scale of international students has become a crucial step in China's path to educational internationalization. Recent years have seen a surge in international students in China, driven by the improvement in the quality and influence of Chinese education, the "Belt and Road" initiative, and the "Study in China" program, leading to a more diverse student body in terms of learning experiences, educational backgrounds, and nationalities[1]. Previous research indicates that China's development experience and achievements, Chinese culture, and job opportunities in China are major factors attracting

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international students, who recognize studying in China as a vital way to enhance personal value[2].

International students, as a unique student group, receive support from schools through one-on-one assistance, traditional Chinese cultural activities, and intercollegiate exchanges to integrate into life in China. However, the sudden pandemic disrupted the education ecosystem, impacting the global education system unprecedentedly. School closures posed challenges for teachers and students alike, affecting international education in China. Travel restrictions led to mobility issues for international students, with many stranded abroad or quarantined in China, prompting a shift from in-person to online learning.

The pandemic has tested international students' psychological resilience with daily life and learning challenges. High daily case counts, social restrictions, and changing school policies have brought their mental health into focus. Due to China's quarantine policies, international students stuck abroad can't return, leading schools to offer online enrollment or deferrals, with some providing refunds. The shift to online learning has dampened their expectations, with lack of real interaction with professors, fewer educational resources, and missing out on experiencing Chinese culture, alongside adjusting to time zone differences for classes, causing significant stress and fatigue.

Students remaining in China were affected by COVID-19 prevention quarantines, disrupting normal life. In response to local prevention requirements, entire areas were locked down if infections were detected, with no exceptions for outings, only self-isolation. Lockdowns were lifted only after all residents tested negative. Universities implemented closed or semi-closed management for international students, significantly reducing their social interactions and offline learning, breaking life balance. Limited on-campus support hindered one-on-one psychological services, prompting schools to organize volunteer teams for essential purchases, leading to feelings of loss of control and severe emotional distress among students.

Although pandemic control measures have eased, international students still face significant decisions due to previous challenges such as being unable to return home, low problem-solving efficiency, and family losses due to COVID-19. These factors influence their future plans, including whether to continue studies in China, graduate smoothly, or seek employment there, leading to a reassessment of their choices, indicating the pandemic's lasting impact[3].

The psychological study of international students holds significant importance for both their personal development and international educational cooperation. Through such research, educational institutions can identify the specific challenges faced by international students and provide targeted psychological health support and resources to help students overcome difficulties. Additionally, studies on the psychological state of international students can offer insights into international educational cooperation, aiding in the formation of more stable and mutually beneficial international educational partnerships.

2 Method

The application of artificial intelligence in student psychological research is expanding. This study utilizes an intelligent e-learning system named the Huanghe e-Learning System (HES).

The system analyzes student behavior patterns and online learning activities, such as login frequency, study duration, and interactions, using machine learning algorithms and recommendation systems to identify potential psychological health issues or declines in learning motivation. Additionally, the smart system processes and analyzes extensive mental health data, aiding researchers in identifying patterns and trends in psychological issues and evaluating the effectiveness of intervention measures.

2.1 Huanghe e-Learning System (HES)

Compared to traditional online learning systems, HES has filled these gaps. HES is a new online learning system integrating recommendation systems and online questionnaire functionalities into traditional online learning systems. The system includes data collection of students' behavioral features, such as psychological questionnaires, online learning behavior, reading behavior, and browsing behavior. And by means of year-on-year analysis, quarter-on-quarter analysis, and period comparison analysis, students' individual data is comparatively analyzed. Tutors can more readily identify real-time psychological issues of isolated university students by analyzing this data. HES has a wide-ranging learning database, including text, images, audio, and video. In addition to academic materials from various university disciplines, the database also contains literature, movies, news hotspots, and other resources of interest to university students. HES is primarily composed of four functional modules: online learning, questionnaire surveys, characteristics collection and recommendation algorithm.

1) Online Learning

The online learning module is mainly used for real-time video teaching between teachers and students. Additionally, the online learning module also calculates students' attendance, homework submission, and homework grading. Teachers can also participate in e-exams, review test papers, and publish exam results.

2) Questionnaires

In order to ensure the correctness and effectiveness of the feedback results of the questionnaire, the preparation of the questionnaire is one of the most important links. We refer to many similar learning motivation scales, such as the "learning process questionnaire" compiled by Biggs[4] in 1987 and the "College Students' Learning Motivation Questionnaire" in 2005[5]. However, using the general learning motivation questionnaire to investigate the students' learning motivation of Ideological and political education, its pertinence is not strong enough, and we hope to specifically understand the psychological motivation related to the learning content of Ideological and political education. After many studies and investigations, we finally built a brand-new "college study life questionnaire" on the basis of the "College Students' internal study motivation questionnaire of Ideological and political education", combining internal motivation and external motivation, to evaluate and quantify the psychological motivation index of college students for ideological and political education. Then, the user characteristic data of college students are collected through questionnaires, and finally a user characteristic database is formed.

3) Characteristics collection

Characteristics collection includes content characteristics collection and behavior characteristics collection.

Content features are mainly divided into user features and course features, as shown in Figure 1:

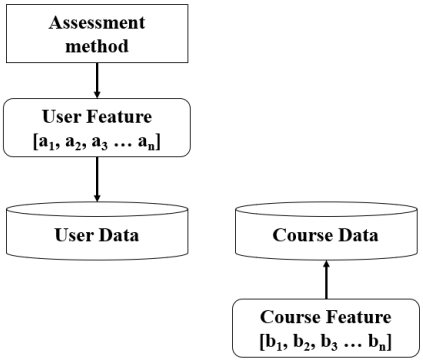

Figure 1. Content characteristics collection.

In order to avoid the inaccuracy of the recommended ideological and political learning courses due to the lack of relevant characteristic data such as behavior characteristics and scoring attributes when the recommendation system is cold started, we collect the user's interest preferences and the guidance bias characteristics of the course itself as our basic database in advance. Then, the user characteristic data of college students are collected through questionnaires, and finally, a user characteristic database is formed.

Behavior characteristics are mainly divided into user behavior characteristics and user evaluation characteristics, as shown in Figure 2:

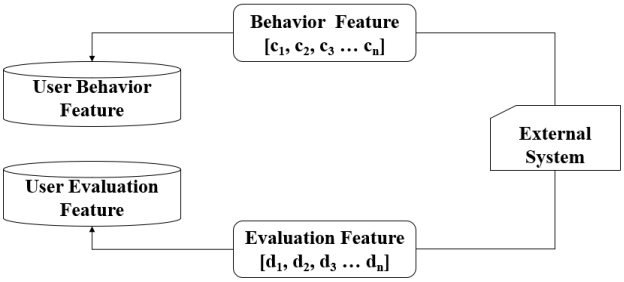

Figure 2. Behavior characteristics collection.

The user behavior characteristics and user evaluation characteristics are mainly derived from the user's use of the recommendation system, and thus the feedback feature factors. For example, after receiving the final item recommended by the recommendation system according to the content, the user collects the browsing time, post viewing evaluation and other related feature data of the recommended item. This feature is real-time and effective. Therefore, it solves the migration of interests caused by the changing psychological motivation of users with

the social environment, and improves the accuracy of the recommendation system. We collect the user's behavior and evaluation data of the recommended items each time, and finally form the user behavior feature database and user evaluation feature database.

In addition, we also collected the library borrowing records of major universities and college students' web browsing records as the initial user behavior characteristic data, so as to further improve the accuracy of recommendation during cold start.

4) Recommendation algorithm

Content-based Recommendation (CB) and Collaborative Filtering Recommendation (CF) are used in the HES system. The system combines them into a hybrid recommendation algorithm, taking into account the education environment of the university.

The CB recommendation algorithm evaluates user characteristics and course characteristics in order to make recommendations regarding content. In addition to making joint recommendations based on the user's psychological motivation, sub-consciousness, values, outlook on life, and other characteristic parameters, it also considers course content characteristics, types, audiences, and other characteristic parameters. Content-based recommendation algorithms are widely used in Social Psychoanalysis[6].

The CF recommendation algorithm is a collaborative filtering recommendation algorithm based on characteristics of user behavior and user evaluation[7]. The system performs collaborative filtering and classification based on the behavior of users, the browsing and evaluation of their favorite items, and it recommends users who have similar preferences to one another in order to complete a recommendation list. In this study, user-CF and item-CF algorithms are used to calculate.

Our recommendation algorithm combines Content-based recommendation and Collaborative Filtering recommendation to form a hybrid recommendation algorithm. For new users of the system, the Content-based recommendation can recommend course materials based on the basic characteristics of users. With the improvement of user data and the capture of user behavior characteristics, content-based recommendation, and collaborative filtering recommendation work in parallel to form a hybrid recommendation, which can more accurately recommend the materials required by users.

2.2 Implementation process of HES system

The implementation process of HES system based on recommendation algorithm is shown in Figure 3.

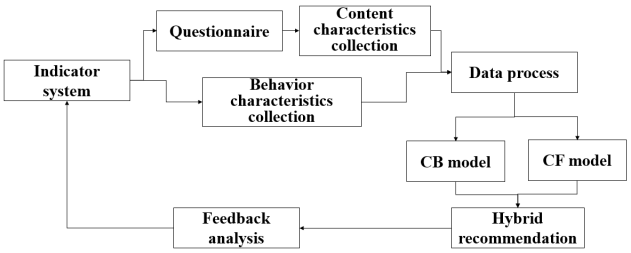

Figure 3. Implementation process of HES system.

First, establish the indicator system of correctness, reliability and safety of content information, system information and feedback information.

Secondly, user characteristic data were collected through university students' questionnaires and content characteristics, and behavior characteristic data were collected through library book borrowing records and computer browsing records, attendance, assignment submission etc.

Third, the data are unified and processed to analyze the content features and behavior features using the content recommendation model and collaborative filtering recommendation model. The content recommendation model and collaborative filtering model are analyzed separately using a weight-weighting algorithm to finally obtain the hybrid recommendation items.

Finally, feedback analysis combines feature data and recommendation feedback to summarize convergent student information and a few anomalies, which are provided to teachers. Professional psychology teachers interview students based on the corresponding information to confirm the students' psychological tendencies. In addition, this information goes into the indicator system to enter the next round of recommendation.

3 Experiment and results

We invited 1107 university students to utilize this system. Of these, 56.4% were Chinese students, and 43.6% were international students; males constituted 47.7%, while females represented 52.3%. The average age of the participants was approximately 23. Our aim was to understand the factors influencing the mental state of international students before and during the COVID-19 environment. We collected relevant data during the testing period, such as teacher feedback, browsing records, browsing duration, category of recommended projects, categories of actively viewed projects, online test scores, etc. We've anonymized the data, retaining only non-sensitive information.

The experiment, in accordance with Chinese university semester schedules, was divided into two stages. The first stage was during the COVID-19 quarantine period, from January to June 2022, and the second stage from September 2022 to February 2023, when national strategies were adjusted, and the quarantine concluded. Each stage lasted for six months. We gathered data such as attendance rate, assignment submission rate, survey results, teacher feedback, browsing records, browsing duration, recommended and actively viewed project categories, online test scores, etc.

3.1 Analysis of gender impact on international students' psychology

We used HES to compare and analyze the online attendance and homework submission rates of Chinese students and international students. This revealed differences in their class attendance under the pandemic context. By analyzing the data from the recommendation system and comparing it to historical classroom teaching or management data, we were able to assess the online learning situation of Chinese and international students using the online recommendation system, as shown in Table 1.

Table 1. Comparison of online attendance and homework submission rates between Chinese and international students.

Chinese students	Male: Online attendance rate is not high, and homework submission rate is good.
	Female: The online attendance rate is normal, but the homework submission rate is significantly lower than the attendance rate.
International students	The online attendance rate and homework submission rate of male and female students have decreased.

We conducted a detailed analysis of data from both Chinese and international students and delved deeper into the underlying reasons for their differences. Furthermore, we compared psychological factors between Chinese and international students to uncover the root causes of these disparities.

Subjective factors include lower self-motivation among international students, exacerbated by the pandemic. Their learning styles often clash with the disciplined, punctual nature of Chinese educational institutions. Social isolation in a foreign country, intensified by quarantine measures, and academic pressures not aligned with their primary goals of cultural experience contribute significantly to their challenges. These factors, combined, impact their academic performance and overall well-being in China.

Objective factors include limitations in learning tools due to varied family backgrounds of international students, and their language skills which affect their proficiency in online platforms. Online classes tend to be less engaging compared to in-person classes, with limited interactive activities like group discussions, which hampers the teaching effectiveness.

3.2 Analysis of the psychological impact of employment on international students

For international students, graduation season tends to bring less psychological anxiety due to cultural differences that allow them to approach it more calmly and relaxedly. They often come from more flexible education systems that prioritize personal development without the need to meet excessive societal expectations. Compared to Chinese students, they typically have a broader employment perspective, leveraging their Chinese language skills and cross-cultural experience for opportunities globally, whereas Chinese students might focus more on the highly competitive local job market. Educated in China, international students often gain bilingual advantages and valuable cross-cultural insights, making them attractive to multinational companies. Their education often emphasizes less on grades, enabling them to face job market pressures more calmly. Society's expectations also differ, with international students encouraged to focus on personal growth and satisfaction[8].

3.3 Analysis of the psychological impact of region on international students

Universities have the characteristic of diverse regional cultural collections. International students come from different countries and represent cultures from different regions. They exhibit different personality traits, learning styles, and thinking patterns. The regional differences also have a psychological impact on international producers.

American students often exhibit traits of independence, innovation, foresight, and collaboration. Their education system encourages personal responsibility for learning, active participation, and self-expression in class. They're motivated to approach problems with fresh, innovative perspectives and demonstrate creativity. In group projects, they show strong teamwork abilities, effectively sharing tasks to achieve common goals.

European students are characterized by independence, civic qualities, openness, and acceptance. Their education system promotes self-directed learning, independent thinking, and free expression in classrooms. They're often educated to respect multiculturalism, environmental protection, equality, and fairness, which fosters a high sense of quality and social responsibility. Additionally, they embrace diverse cultures and viewpoints with an open and accepting attitude.

Middle Eastern students often display a deep respect for and value of traditional and family principles, characterized by strong self-discipline and social skills. Their cultural background emphasizes family and traditional values, fostering a high regard for respect within families and communities. They are encouraged to be self-reliant and possess significant self-control, aiding in their commitment to academic tasks. Additionally, they have excellent social abilities, adept at forming connections and collaborating with others.

African students often exhibit sociability, strong adaptability, and resilience in their personalities. The importance of community and collectivism in many African cultures fosters a preference for teamwork and social interaction. Limited educational resources in many African countries necessitate greater adaptability and creativity to overcome academic challenges. These students often face life challenges such as economic hardships and insufficient educational resources, demonstrating remarkable tenacity and perseverance.

4 Discussion

4.1 Theoretical Contribution

Firstly, this research introduces the application of recommendation systems in the field of psychology. Previous studies have predominantly utilized recommendation systems in online learning, recommending appropriate learning materials based on students' online behaviors. Few studies have applied recommendation systems to analyze students' psychological activities and identify their psychological issues and underlying emotions. Thus, this study expands the application scope of recommendation systems within the educational domain.

Secondly, we propose a more effective psychological education strategy that integrates recommendation systems with online questionnaires. We use the data collected from online questionnaires as the foundational user data for the recommendation system, addressing the initial cold-start problem of recommendation systems. The aim of this study is to provide effective research support for cold-start solutions in psychological education.

4.2 Practical Contribution

We analyzed the results of the HES system trial conducted on 500 international students under quarantine. We found that a significant number of these students experienced psychological difficulties such as depression and anxiety due to the impact of the pandemic.

The literature review indicates that there is a scarcity of research on the psychological state of international students. This study, focusing on international students from several universities in Beijing as the research sample and employing data analysis methods to quantify their psychological state under the pandemic, fills a gap in the field. The findings can serve as a case study, providing references for researchers.

Based on the results of this study, it can serve as a model to provide theoretical basis and guidance for the staff managing international students at universities across China. It also suggests adjustments in line with the actual work conditions to optimize the work with international students at higher education institutions.

5 Conclusion

Given the unique circumstances of the COVID-19 pandemic, we adopted the HES system, which combines intelligent recommendations with survey inquiries. This system thoroughly documented the online learning behavior of international students, such as attendance, homework submission, and behavioral traits, offering more objective and efficient data than traditional surveys. Through HES, we can swiftly intervene and guide students, enhancing the efficiency of instructors. Analyzing HES data revealed psychological distress among students due to isolation. Future research will further utilize HES data to understand students' psychological dynamics in online learning, aiming to improve instructional efficacy. The pandemic's impact on global health and development, particularly in education, underscores the need for effective solutions to psychological challenges and educational sustainability.

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