



## Research on the Application of Human-Computer Interaction in Student Learning Behavior Analysis and Educational Management under Big Data Context

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**SUMMARY:** *With the rapid development of information technology, informatization has become an inevitable trend in modern education. Nowadays, the application of big data and human-computer interaction has brought new ideas and methods to education. This article aims to study the impact of human-computer interaction technology on student learning behavior and educational management in the big data environment. This article selected first-year undergraduate students as the experimental subjects and conducted research using the Zhihuishu online platform as the experimental scenario. The entire experimental cycle included a complete learning cycle, during which students engage in online learning through the Zhihuishu platform. After the end of the learning cycle, a detailed questionnaire survey was conducted on the learning situation of students to collect feedback on the learning process and effectiveness. Moreover, offline interviews were conducted with teachers and students participating in the course to obtain their subjective opinions and experiences. Afterwards, a comprehensive analysis was conducted based on the collected questionnaire data, interview feedback, and learning data on the Zhihuishu platform. The results showed that the Cronbach's alpha of the survey questionnaire reached 0.931, which was relatively reliable. Combined with the interview results, the new education model significantly improved students' learning enthusiasm, self-learning ability, and classroom participation. The vast majority of teachers believed that these technologies helped to understand the learning situation of students and optimize the teaching process. Through data analysis, it can be concluded that students who used online interactive platforms to learn courses performed better than traditional teaching, with a 2% to 5% improvement in their daily and test scores compared to traditional offline teaching. They also showed significant effects in self-directed learning and personalized recommendation learning, with 48.4% of students being able to complete online courses more fully and seriously, and 64.8% of students achieving satisfaction in personalized recommendation learning. It is recommended that online education platforms optimize human-computer interaction design, provide training for teachers, and fully tap into technological potential, improving teaching effectiveness and management level.*

**KEYWORDS:** *Big Data; Interactive Learning Environment; Online Courses; Learning Behavior; Higher Educational Management Work*

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# 1 Introduction

From a historical perspective, since the emergence of information technology, many researchers have conducted research on the integration of information technology and education, known as Interactive Learning Environment (ILE). As early as the 1960s, computers have been applied in the field of assisted teaching. With its development, the personalized requirements for student education in basic education have become increasingly high [1]. Since 1990, the rapid progress and popularization of Internet and multimedia technology have made ILE more perfect. Students can access the rich online learning resources at home without leaving their homes, and the various forms of media also make traditional teaching dull and lively. They are also given the freedom to choose the methods that are suitable for their own learning [2, 3]. At the beginning of the 21st century, with the rapid development of emerging technologies such as cloud computing and the Internet of Things (IoT), big data technology has ushered in new changes, and people have discovered the possibility of its application in various fields. Big data can conduct data mining on student learning behavior, academic performance, and teacher classroom evaluation, helping people complete data analysis [4]. At this point, the design and application of interactive systems have also been widely discussed. Through this interactive system, computers can improve students' learning outcomes by reorganizing cognitive functions, and can also help students integrate their daily life experiences with the knowledge they have learned [5, 6]. In recent years, the further development of technologies such as artificial intelligence has led people's lives and work towards a more intelligent, convenient, and efficient direction, and education has also been greatly affected. Big data can collect behavioral data from students through online learning, such as learning duration, learning content, practice situation, etc. Through machine learning and data mining, corresponding learning models can be established to predict students' learning outcomes. Based on the results, analysis can be carried out to tailor learning plans for each student, and recommend appropriate exercise questions and courses [7-9]. For teachers, big data is also an excellent auxiliary tool. Teachers can analyze teaching data, evaluate teaching methods, identify teaching problems, and provide early warning for students' learning difficulties, helping teachers to intervene in advance [10, 11]. In addition to big data, human-computer interaction technology has also gained public attention due to the development of artificial intelligence, and has been applied in various industries. In terms of education, chatbots and virtual assistants, as representatives, are deeply loved by students. They help students who are afraid to ask teachers or have no time to answer questions to solve problems in a timely manner. The interactive platform Q&A (question and answer) method also helps students engage in online discussions and simulated experiments, improving learning efficiency and experience [12, 13]. The intelligent teaching assistant brought by human-computer interaction technology can also assist teachers in classroom management, provide teaching advice, and help teachers reduce their workload [14]. Daily teaching resources such as homework, classroom PPTs, and screen recordings can also be stored and shared through interactive platforms. At the same time, experiences can be exchanged or collaborative teaching can be carried out with peers. Teachers can even participate in training and learn through these platforms, improving their teaching skills and knowledge level. In practical application, human-computer interaction technology cannot be separated from the help of big data, and the dynamic adjustment interface and interaction mode of interaction systems cannot be separated from the analysis of real-time data by big data [15]. In addition, in complex human-computer interaction processes, the system requires big data to provide decision-making support, making the system more automated and intelligent [16]. Overall, in

the field of education, human-computer interaction technology cannot do without the powerful predictive and analytical capabilities of big data. Big data also relies on human-computer interaction to improve its application effectiveness. The combination of the two enables these technologies to meet the changing needs of customers, making them shine brightly in education and various fields.

Many countries attach great importance to the development of education and have also explored the rational application of information technology in education. Some countries have introduced relevant information technology education regulations, which mention “improving the level of information technology application for teachers”, “encouraging students to use information technology to actively learn and learn independently, and enhancing their ability to analyze and solve problems using information technology” [17]. This is enough to reflect the level of attention that the public places on educational informatization at the national level today, and countries have also invested a lot of manpower and material resources in this regard. However, in terms of the results and effectiveness, informatization has not shown its expected effect [18]. However, this path of information-based education must be taken, not only to improve educational levels, but also to promote educational equity and provide students with more resources and interactive opportunities. It is necessary to further promote the integrated application of information technology and education and teaching, and promote the development of “education+Internet” [19]. The integration of information technology and classroom environment is beneficial for teachers to use various forms and contents, such as various online hotspots, cutting-edge discoveries, etc., to explain to students through pictures, PowerPoint, and even animations, helping students to have a deep understanding and learning, and breaking the limitations of traditional teaching [20]. Students can obtain relevant information through information platforms and showcase their learning outcomes in various ways, which traditional teaching cannot achieve.

This article is based on the big data of the Zhihuishu learning platform, with undergraduate students as the research objects. The statistical analysis of student learning behavior is conducted through a combination of questionnaire surveys and Zhihuishu backend records. In the form of teacher-student interviews, the experiences and opinions of teachers and students on new technologies are collected, and the learning effects of the Zhihuishu course and offline classroom final grade analysis are compared to explore the impact and role of online classrooms combined with human-computer interaction technology on students and educational management in higher education in this era of big data, as well as people's acceptance of new technologies.

## 2 Processes

### 2.1 Investigation

The subjects selected in this article are 284 undergraduate students who choose the same public elective course as the experimental group. In order to compare the learning outcomes, 231 students who only participate in offline courses or traditional teaching methods are selected as the control group. To ensure that students have a basic consistent learning foundation, the selection criteria for elective courses are set for freshmen, so that the teaching effects of the experimental group and the control group are comparable.

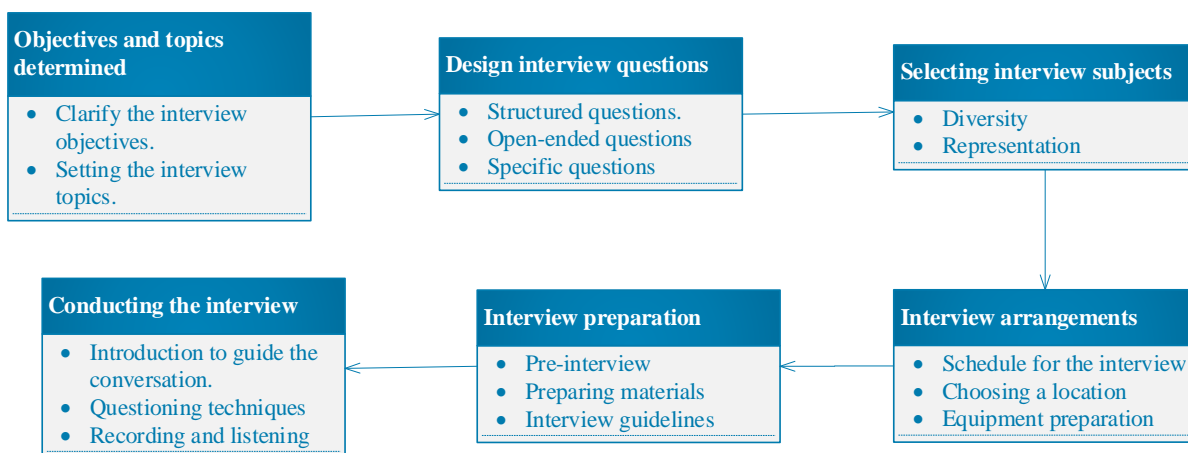
In order to conduct reasonable research on learning behavior, the survey questionnaire designed in this article adopts the form of Likert Five Measures [21]. The questionnaire includes basic information of students (such as names not obtained to protect privacy), online learning behavior evaluation, and open opinions. Excluding basic information and open-ended

opinions, the focus of the learning behavior section is distinguished by five levels, ranging from “strongly disagree” to “strongly agree”, with scores ranging from 1 to 5. The higher the score, the more relevant the subject is to the problem description. This design has strong flexibility and can be adjusted according to experimental needs. If the experiment requires a more detailed level, adjustments can also be made to the number of levels. Moreover, this standardized form of answer also brings great objectivity to the scale, reducing the subjective impact on respondents [22]. It is easy for the surveyed subjects to understand, enabling them to express their ideas more clearly and quickly. In addition, this survey design can quantitatively measure the attitudes and opinions of the respondents. The simple and easy to fill feature is also very suitable for large-scale investigation and research. The questions set in the questionnaire are also closely related to the investigation of learning behavior, such as “I have a high overall satisfaction with the course”. This question may seem to measure students' satisfaction with the course and evaluate its popularity, but in reality, it is also a test of whether courses with high satisfaction can stimulate students' learning enthusiasm; furthermore, “I regularly schedule time to study this course every week”, which not only helps to understand students' learning habits and time management, but also reflects the regularity of their learning behavior. Questions like “personalized feature recommendations on the platform are very helpful to me” are aimed at investigating students' level of recognition and effectiveness in this type of big data human-computer interaction.

## 2.2 Interviews with Teachers and Students

Compared to closed ended questions in questionnaires, which limit the expression of the surveyed subjects, interviews have a unique advantage [23]. In interviews, researchers are able to understand and explore the interviewee's thoughts through open-ended questions. In the case of limited questionnaire content, targeted follow-up questions can also be conducted during interviews. In terms of accuracy in collecting data, longer questionnaires are also difficult to ensure the accuracy of answers. Interviews can stimulate the participation of respondents and improve the quality of collected data through question clarification and guidance [24]. Both have their own advantages and disadvantages, so this article requires interviews for auxiliary research.

The interview in this article needs to go through several stages as shown in Figure 1. Setting the interview topic is not only a supplement to the questionnaire survey, but also to understand the impact of today's information platform on student learning and teacher teaching. The selected interviewees are some teachers and classmates from the research course. Considering the diversity of objects, the selected students are mostly from different majors. The interview time is set after the final grades are released, ensuring that everyone has been learning or teaching on the platform for a period of time. The location of the interviews is set at the convenience of the students and teachers in the nearest office or coffee shop, and the atmosphere is as relaxed and comfortable as possible. In addition, each interview is recorded (with the consent of the person concerned) and notes are taken to facilitate the subsequent statistical confirmation of the contents.



*Figure 1: Interview process*

The design of questions in the interview is crucial. This interview mainly designs three types of questions, namely developmental questions, structural questions, and specific questions. Open-ended questions are a relatively broad type of question that requires respondents to express their thoughts in their own words. This can provide a deeper understanding of the interviewee's views and values, and sometimes even provide more in-depth and detailed content [25]. For example, “What do you think are the differences in teaching methods and student interaction between online classrooms and traditional classrooms?”. Structural questions are questions with clear options, giving respondents the right to choose, allowing them to analyze and compare different options, which can better maintain the theme of the interview without deviating from the topic, and also understand the preferences of the respondents [26]. For example, “Which one do you think is more helpful in understanding and mastering knowledge compared to online classrooms and traditional classrooms? Why?”. Compared to the previous two types, specific questions may have higher requirements for respondents, requiring them to provide specific information and suggestions. This is also to gain a deeper understanding of the interviewee's thinking process and determine the next research direction. When conducting interviews, it is important to give the interviewee enough time to think [27]. For example, “What specific technical obstacles do you encounter when using a specific online classroom platform? How do you think these obstacles can be solved?” Based on the theme of this interview, these questions distinguish whether the interviewee is a student or a teacher, ensuring that corresponding information can be obtained, such as students' learning attitudes and ideas, teachers' attitudes and changes in teaching, etc.

Before the interview, in addition to preparing questions, it is also necessary to write interview guidelines and conduct pre-interviews. The purpose of an interview guide is to clarify the direction of the interview, and plan the content and process of the subsequent interview in advance, which reduces the embarrassment of the initial interview and provides a sense of security, enabling the interview to proceed more smoothly [28]. The information to be included in the interview guide includes basic information about the interviewee, the topic of this interview, a list of interview questions mentioned earlier, and precautions during the interview. When conducting interviews, it is important to respect the viewpoints of the interviewees, encourage them to share their own experiences, and also control the pace of the interviews, leaving enough time for them to fully reflect and express themselves. Pre-interviews, on the other hand, are a simulation conducted before the interview. This article adopts an online pre-interview model to gain a preliminary understanding of the

interviewee's views, test the effectiveness and feasibility of the interview questions, and establish initial trust with the interviewee to alleviate the tension during formal interviews [29].

Finally, the formal interview begins with a relaxed conversation, where the interviewer asks open-ended questions and guides the interviewees to share their thoughts. Based on the interviewees' answers, the interviewer further questions and delves into the topic to ensure that the information obtained is comprehensive. At the end of the interview, the interviewees are thanked for their participation and sharing.

### 2.3 Platform Data Acquisition

Although two research methods, questionnaire and interview, are used, it cannot be denied that both have shortcomings that cannot be avoided. The research subjects may lack accuracy in answering questions based on what they think the researcher wants. Improper setting of the two types of questions may lead to misunderstandings among the research subjects. Moreover, forms with strong subjectivity like this can easily lead research subjects to intentionally provide false information or erroneous information caused by recall bias [30].

Therefore, in addition to questionnaire and interview methods, this article also collects some information through the platform.

As one of the online education platforms for higher education, Zhihuishu provides a large number of online education resources and places great emphasis on teacher-student interaction and personalized learning. The platform also utilizes big data and artificial intelligence technology to provide personalized learning content and routes for students, and improves the learning experience and teaching quality through online quizzes and certificate authentication functions. Online learning in the Zhihuishu mainly has the functions shown in Figure 2.



Figure 2: Zhihuishu function module

Firstly, it is necessary to determine the data to be collected. The first point is the learning time of students, which is used to understand their learning frequency and time distribution, that is, learning behavior habits; next is classroom participation, with video watching records and even records of time and frequency of absences. By analyzing this data, the problems in the course and the online learning situation of students can be understood; interactive data is also an indispensable part. Communication between teachers and students through the platform's interactive area can reflect which students are actively learning and which are passively learning. It can also reflect whether new technologies are effective in changing educational models; another aspect is the recommendation of personalized courses on the platform. By analyzing the content preferences of students, the platform recommends suitable courses. By confirming this information, the effectiveness of the platform's human-computer

interaction can be known; finally, of course, it is the collection of academic performance data. The improvement brought by human-computer interaction technology under big data to higher education needs to be explored through grades.

Because the data involves personal information of teachers and students, the data is collected proactively from the research subjects. Among them, personalized data refers to the proportion of recommended courses on the research platform homepage that meet personal preferences. Finally, the statistical integration of the data is carried out.

### 3 Results

#### 3.1 Questionnaire Reliability and Validity

Firstly, a reliability and validity analysis of the questionnaire is conducted, using the Cronbach's Alpha [31]. This coefficient is a commonly used statistical indicator to evaluate the internal consistency of a questionnaire, which can determine whether a set of items can be measured as a whole for a specific latent variable or construct. The calculation formula is shown in Formula (1).

$$\alpha = \frac{N}{N-1} \left( 1 - \frac{\sum_{i=1}^N \sigma_i^2}{\sigma_T^2} \right) \quad (1)$$

Among them, N is the number of items;  $\sigma_i^2$  is the variance of item i;  $\sigma_T^2$  is the variance of the total score.

To simplify the operation, this article uses SPSS to calculate the correlation of the collected questionnaire's Likert Five Measures information survey section. The reliability of each item is shown in Table 1. The average Cronbach's Alpha of the entire survey questionnaire is 0.931, indicating good overall reliability of the questionnaire.

Table 1: Reliability of each item

Item	Mean Scale Value after Deletion	Variance of Scale after Deletion	Item-Total Correlation	Cronbach's Alpha after Deletion
1	4.1	0.451	0.714	0.926
2	4.3	0.519	0.734	0.931
3	4.214	0.479	0.723	0.932
5	4.357	0.473	0.738	0.934
6	4.171	0.489	0.725	0.929
7	4.1	0.476	0.714	0.927
8	4.214	0.464	0.719	0.929
9	4.471	0.441	0.754	0.935
10	4.3	0.453	0.735	0.933
11	4.071	0.481	0.713	0.926
12	4.286	0.469	0.729	0.931
13	4.2	0.458	0.726	0.93
14	4.014	0.453	0.699	0.937
Overall Mean	4.215	0.470	0.725	0.931

Afterwards, the validity of the collected scales is analyzed using Principal Component Analysis (PCA) [32, 33]. Using SPSS, the value of KMO (Kaiser-Meyer-Olkin) [34] is calculated to be 0.85, which is greater than the standard of 0.8. The value of Bartlett's sphericity test [35] is less than 0.05, indicating that the questionnaire data is suitable for factor analysis and the design is well-designed.

### 3.2 Data Results Statistics

Firstly, based on the data collected from the questionnaire, the average score for each question can be obtained, as shown in Figure 3. As shown in Figure 3, in this emerging learning environment, most students can maintain good learning habits and have a good evaluation of this new learning mode.

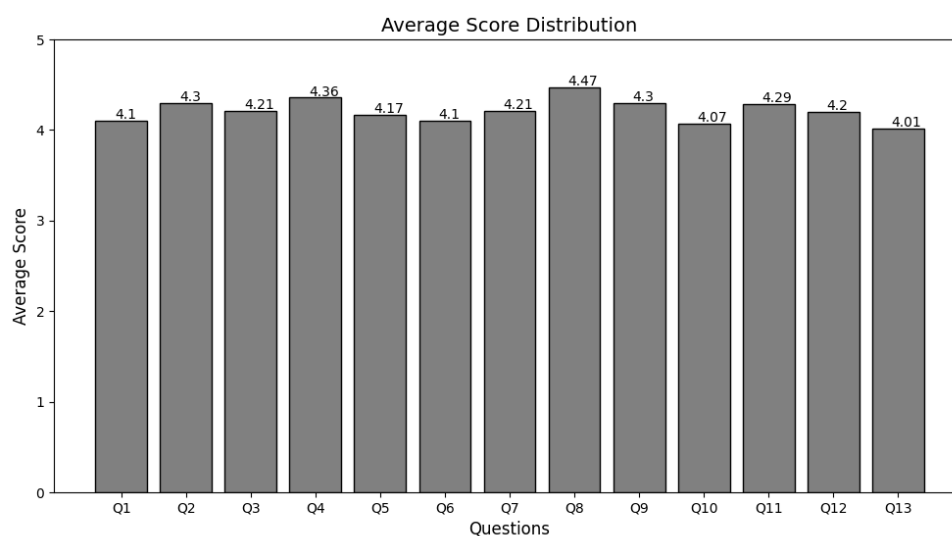


Figure 3: Average score of each question in the questionnaire

Afterwards, a statistical analysis of the interview results is conducted. According to the interview results, it can be seen that students have a good learning experience with online human-computer interaction, among which online Q&A and discussion are their favorite functions. Many students use this function to solve questions and improve learning effectiveness. Many students also express that this classroom model is more suitable for courses that require online practice, which can stimulate students' active learning and thinking. In addition, students also express their hope to strengthen the strictness of online teaching, improve the operation and performance of the platform, and provide clearer usage guidelines and course introductions.

For the analysis of interview results with teachers, most teachers believe that this teaching model can better utilize the rich teaching resources on the Internet, and can also accurately control the learning status of students in class, understand the completion of homework, and reduce workload. A small number of teachers prefer traditional teaching methods due to reasons such as lack of technical proficiency. Most teachers also believe that online teaching can provide students with greater self-learning space, stronger interactivity than traditional classrooms, and higher classroom activity. In addition, teachers also hope to receive professional training to enable them to fully utilize the various functions of the platform.

The next step is to combine the platform's backend data to verify the authenticity of learning behavior and learning effectiveness. Figures 4 and 5 are obtained from the collected data. 48.4% of students are able to listen to the course seriously or even completely even in

online teaching, but there are still a small number of students who cannot listen attentively. In the interactive discussion section, the statistical table is divided according to the course schedule cycle, and it can be seen that the enthusiasm of students and teachers is gradually increasing, especially during the mid-term and final exams in weeks 10 and 16. At this time, the interaction between students and teachers reaches its peak, which is about 50% higher than usual. This further illustrates the positive impact of online human-computer interaction on education. To standardize, the preferred course types are uniformly defined as courses related to the student's own major, and a recommendation preference ratio of over 40% is defined as student satisfaction with the recommendation algorithm. The larger the proportion, the more personalized the courses recommended by the platform. From the statistical data of personalized recommendations, it can be seen that 64.8% of students recommend courses that are more than 40% of their preferences, and even 19.7% of students recommend courses that are very in line with personal preferences, with over 90% of their courses meeting personal preferences. This shows that the platform's personalized recommendations are still very in line with the preferences of students, but there are still some recommendations that do not quite meet their preferences and still need improvement.

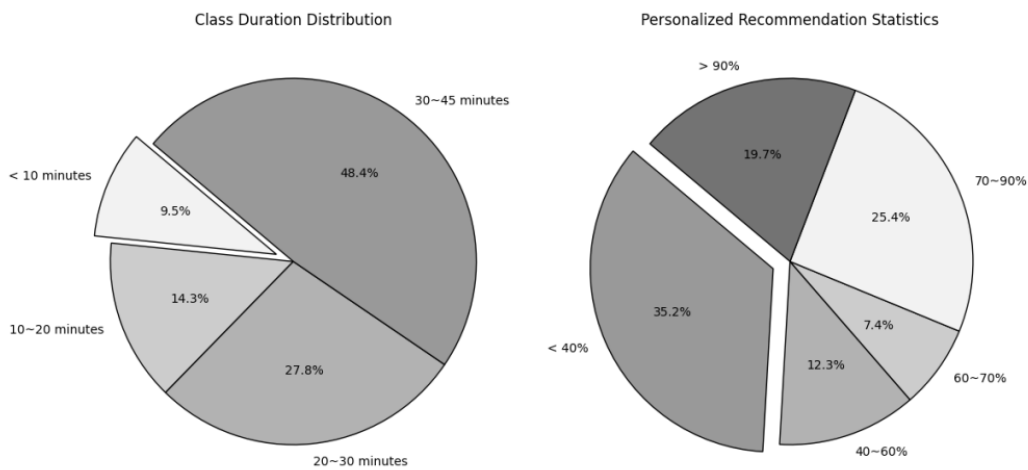


Figure 4: Personal preference statistics of students focusing on class time and the proportion of personalized recommendations

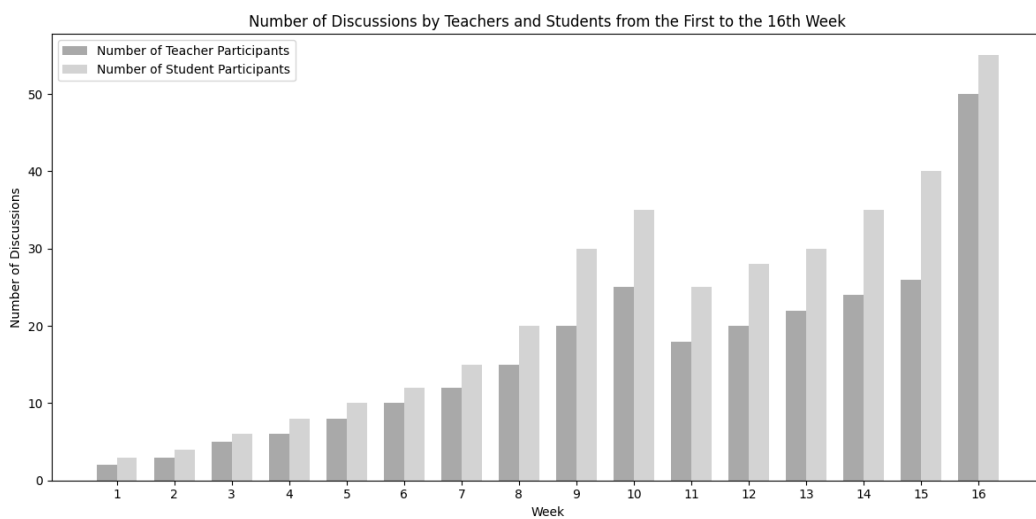


Figure 5: Interactive discussions during the semester

Finally, a comparison of learning outcomes is conducted. By organizing the weekly homework scores and mid-term and final exam scores, the changes in traditional teaching and online learning scores within a semester are obtained, as shown in Figure 6. When facing a relatively new course of study, everyone has a low level of mastery of the course and their grades are not ideal. With continuous learning of the course, it can be seen that everyone's academic performance is constantly improving. Overall, online human-computer interaction has a more significant effect on improving student homework and average exam scores. Especially in critical midterm and final exams, the score of online human-computer interaction is significantly higher than that of traditional teaching, with an improvement of approximately 2% to 5%, indicating that this teaching method has significant advantages in enhancing student learning effectiveness and exam performance. Although traditional teaching scored slightly higher than online human-computer interaction in some weeks, the overall trend indicates that online human-computer interaction performs better in most cases.

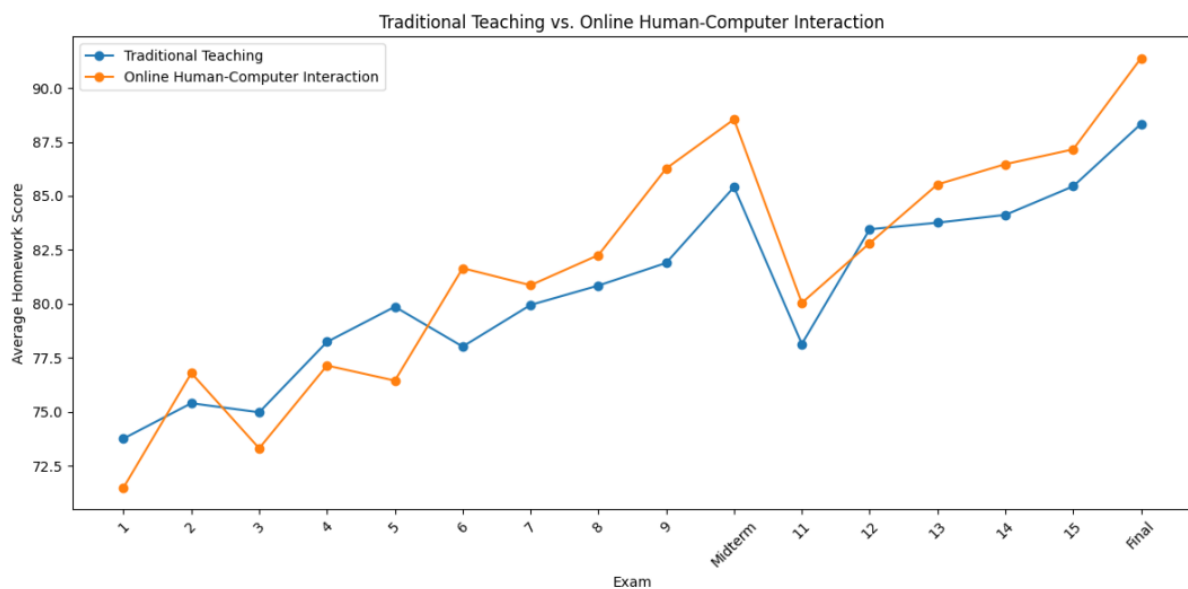


Figure 6: Comparison of changes in academic performance between traditional teaching and online learning within one semester

Based on the analysis of the previous data analysis structure and interview results, the following two points can be drawn:

(1) The online classroom combining big data human-computer interaction has improved students' learning enthusiasm. Overall, students who study under the new mode perform better than those who study under the traditional teaching mode. In this learning environment, most students have a longer focus time in class and are able to actively complete classroom tasks. Moreover, from the perspective of interactive learning behavior, this learning mode has led to more people daring to speak up and promoted students to actively engage in behaviors that are beneficial to learning. In addition, personalized recommendation methods have also exposed many students to different fields from before, broadening their horizons. However, this kind of learning also has its drawbacks. The learning environment for students is more free compared to traditional teaching. However, for some students who are not very disciplined and like to be lazy, the time for serious learning is actually reduced, and learning efficiency is reduced. Therefore, this learning method needs to strengthen the supervisory role of teachers, and the best situation is to help students develop good learning habits, which is also one of the future research directions.

(2) The combination of interactive technology and big data makes teaching management easier and more effective. Teachers use the platform to quickly understand students' classroom attendance and daily homework situations in the form of data charts, and provide relevant suggestions for different students' learning situations. Based on the overall learning situation of the class, teachers can also adjust teaching content in a timely manner and integrate and optimize their own educational resources through online resources. In this technological context, the education management departments of universities also better analyze teaching processes, improve work efficiency, and make the entire teaching work more rigorous and standardized. However, the education management achieved by universities today is still insufficient. Some universities only obtain data from platforms, which is far from fully utilizing big data. Sometimes, universities should improve their management awareness and strengthen investment in related areas. In addition, some platforms have complex operations, and universities also need to establish an effective platform to strengthen technical training for teachers, so that they can better support information education work.

## 4 Conclusions

The research results show that big data human-computer interaction technology can play a huge role in the field of education. Among them, online learning platforms, as a representative, have had a huge impact on the learning behavior of students and the educational management of universities. For most students, this completely different approach from before makes their learning more free and even more focused, allowing them to exert subjective initiative to explore deeper and broader knowledge. In terms of higher education, online learning platforms help teachers scientifically evaluate students' learning situations and organize teaching materials to reduce teaching burden, improve teaching processes, and promote the good development of higher education. However, incomplete technological development and insufficient skills of relevant personnel are still its shortcomings. Therefore, universities must strengthen infrastructure construction and professional talent cultivation, promote the integration of information technology into the education system, and provide assistance for cultivating high-precision and cutting-edge talents and optimizing educational management work.

## About the Author



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