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Artificial Intelligence Implementation in Higher Education in China: Case Study of Beijing Technology and Business University

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Abstract

With the swift development of technology, there is an increasing number of Artificial Intelligence (AI) technologies entering into different social fields such as education, healthcare, logistics and chemistry. This research focuses on higher education (HE) field. Previous studies placed more emphasis on the delivery of teaching and learning while ignoring the management of education (Dogan et al., 2023). Besides, most researchers just focused on one application of AI. Therefore, this research is trying to bridge these gaps to explore how AI can be used in higher education to improve the delivery and management of teaching and learning from the aspects of applications. The research follows a qualitative method and a case study of Beijing Technology and Business University (BTBU) collected data from internal documents, internal organisational reports, media articles, official website articles and patent. It uses the framework of López-Chila with slight modifications. There are four main applications in BTBU: intelligent tutoring systems, adaptive systems, assessment and evaluation and analysis and prediction.

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Keywords: Artificial Intelligence (AI); higher education (HE); teaching and learning; delivery and management

Introduction

With the first Artificial Intelligence (AI) system built, AI involved in different techniques such as expert systems, machine learning and robots. However, AI has not been developed until the 21st century when the information environment became richer. Meanwhile, the development of Big Data, e-commerce and computer technology led to the beginning of a new era of AI (Melhuish et al., 2016). The demand for AI products is growing gradually. At

present, AI has been filtered into everywhere of the production process and human daily life such as education, healthcare, logistics and chemistry.

As for AI in higher education (HE), Popenici and Kerr (2017) pointed out that AI technologies provided tremendous opportunities for worldwide education and changed the nature of higher education. Rather than just learning from paper textbooks with the traditional face-to-face teaching mode, students can make full use of advanced AI technologies today such as intelligent tutoring system and virtual reality. On the other hand, AI has made the concept of Smart Campus become reality integrating advanced technologies including the Internet of Things (IoT), data analytics and automated systems to create an intelligent educational environment in order to enhance the experience and efficiency of education institutions. Traditional campus implements the face-to-face teaching strategy, however, smart campus focuses on developing innovation education which provides more services like smart classroom and e-learning (Kinshuk et al., 2016). Smart campus brings benefits to higher education including the aspects of teaching, management, and service. It furthers the possibilities for new AI applications and services, which supports the delivery and management of teaching and learning in universities.

In the era of Artificial Intelligence, China is continually researching ways to upgrade the higher education strategies and methods. With the rapid growth in AI capabilities of the 21st century, it has already established a relatively complete educational information system which has essential strategic meanings for higher education institutions worldwide. Meanwhile, there is an increasing number of technology companies in China which place emphasis on providing more AI technologies to university campuses with the aim of realizing a better intelligent university information campus. Those companies devote to develop more intelligent education platforms for university campus, which provides a huge boost to the development of AI in HE in China.

In terms of Beijing Technology and Business University (BTBU), it was established in 1999 through the merger of Light Industry College Beijing and Business College Beijing which combined the strengths of engineering and business education. This university emphasises science and business innovation which prioritizes research in emerging fields including Artificial Intelligence, Big Data and other sustainable technologies. BTBU invests time and money in virtual laboratory platform, advanced scientific research platform and engineering research centre to support innovative projects which is at the leading edge of technological development.

Literature Review

Higher Education Modes

In the earliest times, all students in higher education institutions (HEIs) were engaged in day-to-day classroom activities and received homogeneous education, which was a structured teaching pattern. Students acquired knowledge in the same way and at the same time and speed while teachers determined and adjusted teaching contents and time accordingly. Examinations were adopted to evaluate the results of teaching after courses ended. Originally,

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HEIs were heavily weighted in favour of providing basic skills for students, however, there was an increasing demand for different skills in the society to produce better goods and services after stepping into Industry Society (Christensen et al., 2008). Therefore, HEIs shifted their focuses to the cultivation of different kinds of students with different skills who were assigned to different grades and majors. Overall, the above embodies the traditional face-to-face (F2F) teaching mode focusing on social interaction between teachers and students and among students which was essential for the delivery and management of education.

Online teaching mode was proposed in 1991 which referred that there was no need to go to campus for students who were able to learn various knowledge according to their individual requirements (McKenna et al., 2022). It consists of two forms: asynchronous teaching and synchronous teaching. In terms of asynchronous teaching, pre-recorded course materials are sent out to all students via the Internet's world wide web including texts, audios and videos. As for synchronous teaching, the interaction between teachers and students happens in real time, which is similar to the traditional F2F teaching mode. In 2020, the main mode of learning in HEIs changed suddenly because of the outbreak of COVID-19. In order to reduce infections, most education authorities decided to make it mandatory for all teaching staff and students to work and study at home. Online teaching mode was strongly needed for the delivery of teaching and student learning during that time. Therefore, higher education mode shifted from traditional F2F teaching mode to the completely online teaching mode during the pandemic.

Blended teaching mode is defined as 30% to 70% of online teaching combining face-to-face teaching (Ubell, 2017). It provides better learning and teaching quality compared with F2F and online teaching mode since it synthesizes the pros and cons of both F2F teaching and online teaching which is a novel education mode for higher education. Nowadays, the COVID-19 pandemic has already turned for the better, however, it still exists and has a certain impact on people's everyday life. Hence, large amounts of HEIs are adopting blended teaching mode for the delivery of education in case of the extensive transmission of the virus in the campus.

AI Implementation in HE in China

In 2017, China published a report to put forward Artificial Intelligence to national strategies (China's State Council, 2017). A year later, MEPRC (2018) stated that AI could be used in colleges and universities to improve methods for instruction and management which helped the country to cultivate more talents for the society. Therefore, it is of great importance to combine AI with HE with the aim of enhancing national strength in AI field and producing more tremendous AI strategies.

With the swift development of AI for the last decade, China has basically built a complete higher education system combining with AI technologies. It is trying to focus more on the areas of tutoring and examinations currently. 'WEI Teaching Assistant' was launched by Central China Normal University for the delivery and management of teaching and learning which offered the functionalities of check-in, group management, exam-monitoring and

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analysis of exam results (Hao, 2021). Smart Class, new high-end classroom, could be used in colleges and universities in China with IoT and cloud computing, which was a good way to provide personalized tutoring services and learning schemes. For example, the facial recognition system in Smart Class can capture the state of students and teachers in class to analyse study situations of students and teaching results of teachers. Moreover, China sets up its own platform of massive open online courses (MOOCs) which is the largest open course platform in the world and covers almost all professional disciplines in higher education. Overall, China is devoted in implementing AI in higher education to achieve common prosperity of all colleges and universities in China.

Although AI is advancing quickly in China which indicates that China is expected to be the greatest country for AI technologies, there are still imperfections with the implementation of AI in HE. Niu et al. (2019) pointed out three real problems to be resolved. The first problem is that it is hard for AI systems to update course contents constantly and immediately to maintain the accurate professional information. Secondly, there are colleges and universities which only place emphasis on online courses and ignore the important role of assessment and guidance of AI system. In addition, most colleges and universities in China adopt large-size class, which means that conducting individualized teaching becomes difficult to carry out for AI system. Overall, in terms of China, existing AI systems in colleges and universities have not met all requirements for higher education yet.

As for the studies on AI in HE in China, researchers should always regard higher education in China as a whole instead of focusing on considering the huge differences of regions. Ding (2018) stated that there was no need to consider too much of the structure and mode inside the institution when studying on AI implementation in HE in China. This is because the higher education policy in China is based on the principle of the uniform national policy. On the other hand, as for a particular college or university, the internal situations of the organisation are complicated which might be unrelated to the research on AI in HE in China.

Methodology

The research follows mono qualitative method which refers to using a single qualitative research method within a study to get a deep understanding of the research subject from a subjective and contextual perspective to explore its aims and meanings. This study explores a better teaching mode adapting to the values and thoughts of students and teaching staff, which conforms to the qualitative research.

As for the research strategy which helps achieve the aims and objectives of the research and is throughout the whole research, a case study will be used in this research to study the chosen field in depth and from different perspectives. This research explores the implementation of AI in HE in the Chinese context, which means that in order to gain deeper insights of AI and HE in this country case study is suitable for the research strategy. The method for data collection in this study is secondary data collecting from internal documents and reports and articles from media and official organisations.

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The analysis of AI applications in HE takes from the framework of López-Chila et al. (2023) and makes small changes, which is from four aspects: intelligent tutoring systems, adaptive systems, asessent and evaluation and analysis and prediction.

Analysis

Intelligent tutoring systems

In 2023, 11 kinds of smart classrooms were completed in BTBU integrating new technologies such as 5th Generation Mobile Communication Technology, Artificial Intelligence, Big Data, Cloud Computing, Augmented Reality (AR) and Virtual Reality (VR) to create more personalized and interactive learning environments (Huaqiyun, 2022; Academic Affairs Office of BTBU, 2023a; Admissions offices of BTBU, 2023a). Six of them are highly related to AI: General Classroom, Flexible Grouping Wisdom Classroom, Self-service Recording Studio, Virtual Simulation Training Classroom, Function Reuse Language Classroom and Exploration Classroom.

General Classroom ensures daily teaching works. Teachers might not be used to typing on the keyboard. They can use the electric pen to write class notes in this smart classroom. The system in General Classroom realizes attendance records with facial recognition technology to improve the teaching management efficiency of the university. It can also carry out the invigilating responsibilities for examinations. Moreover, gestures and voice commands recognition are used to control the projector and the screen fluctuation combining new technologies such as machine learning, pattern recognition and motion modelling to measure position of users' hand to perform Human-Computer Interaction (Wu & Huang, 2001; Admissions offices of BTBU, 2023a).

As for Flexible Grouping Wisdom Classroom, students are grouped into different groups by the system based on their learning abilities and personalities to ensure that each group has different kinds of students to help and learn from each other (Academic Affairs Office of BTBU, 2023a; School of Food and Health, 2023a; Adamson et al., 2014). All students have the devices in the desk used to answer questions to participate in interactive activities. They can get feedback of their performance from the system after class. Figure 1 shows the page of the system for this classroom from the perspective of teachers. Group statuses are in the right side of the platform. Teachers check the learning state of students in the classroom who can monitor students' actions and gain a better insight into students' abilities (Casamayor et al., 2009; School of Food and Health, 2023b). By clicking on 'Monitor', teachers can get the feedback report of any group to obtain more information on students' learning. If students make mistakes when discussing in groups, the AI system will capture the mistakes, and 'Interact' will change to red to remind teachers to help them.

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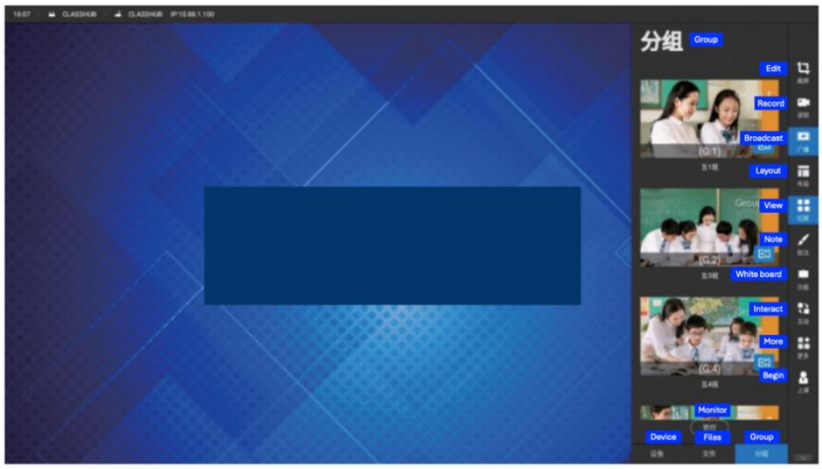

***Figure 1*: Teacher client in Flexible Grouping Wisdom Classroom**
(Source: adapted from Academic Affairs Office of BTBU, 2023a)

The Self-service Recording Studio is constructed for recording classes, micro-lectures and MOOCs which can be viewable by students all over the world. In figure 2, 4K HD cameras provide multi-camera shooting and post-production editing. They are used simultaneously to capture a scene from different angles. As lecturers walk round the classroom, the localization analyser traces their eye movements and analyses the positioning information recording what they want to emphasise so that students can take notes more easily.

***Figure 2*: Self-service Recording Studio**
(Source: adapted from Huaqiyun, 2022)

In Virtual Simulation Training Classroom, students wear VR headsets and AR glasses to do virtual simulation experiments, which can play a useful supplementary and deepened role for the real experiment to avoid accident happened (Huaqiyun, 2022; Ramírez et al., 2018). 'ServerAssian', a tracker server, monitors real-time location data, route history and movement patterns of students when doing virtual simulation experiments (Academic Affairs Office of BTBU, 2023a). VR simulation integrates with AR which enhances the virtual interactions, while AI system analyses the student's interactions to adjust the experience in real-time. Combining AR, VR and AI can create immersive and adaptive learning environments (Gandedkar et al., 2021).

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In terms of Function Reuse Language Classroom, each student is equipped with a computer for language training. Students enter words or sentences in the language training platform, and then get explanations and video demonstrations of the correct mouth and tongue positions from AI assistants. The mock exam is one of the chief functions of this classroom. Students can get experience from the test simulation system by actually experiencing the test environment. The system simulates four formal language tests which are shown in figure 3: Test for English Majors Band 4 (TEM4), Test for English Majors Band 8 (TEM8), Business Foreign Language Test (BFT) and Hanyu Shuiping Kaoshi (HSK). During the mock exam, the system will remind students if their voices cannot be heard well enough by the computer to recognise what they are saying. After the exam, it provides the analysis of the test result and personalized feedback according to their performance and concentration during the test so that students can find their weaknesses and strengths.

***Figure 3*: Mock exams in Function Reuse Language Classroom**
(Source: adapted from Academic Affairs Office of BTBU, 2023a)

Exploration Classroom allows classes held both online and offline. It enables students in different regions to have access to real-time teaching and learning and also achieves interaction and quiz (School of Food and Health, 2023b; School of Food and Health, 2023c). Three screens are used in computer assistant teaching so that teachers can know the learning demands of students to adjust the teaching methods and contents in time which are shown in figure 4. The first screen is used for teaching. The second screen displays the performance of online students during the class. The third screen shows data analysis of the classroom situations.

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***Figure 4*: Exploration Classroom**
(Source: adapted from Huaqiyun, 2022)

Adaptive systems

Adaptive systems in BTBU have two aspects: laboratory and course management which promote the university management standardization and efficiency (Join-Cheer, 2024; School of E-Business and Logistics of BTBU, 2023).

AI supports the construction of laboratory management system of BTBU to make experiments standardized, safe, intelligent and scientific (Recruitment and Employment office of BTBU, 2023). The framework of laboratory management system can be seen in figure 5 which shows how the system works with AI technologies.

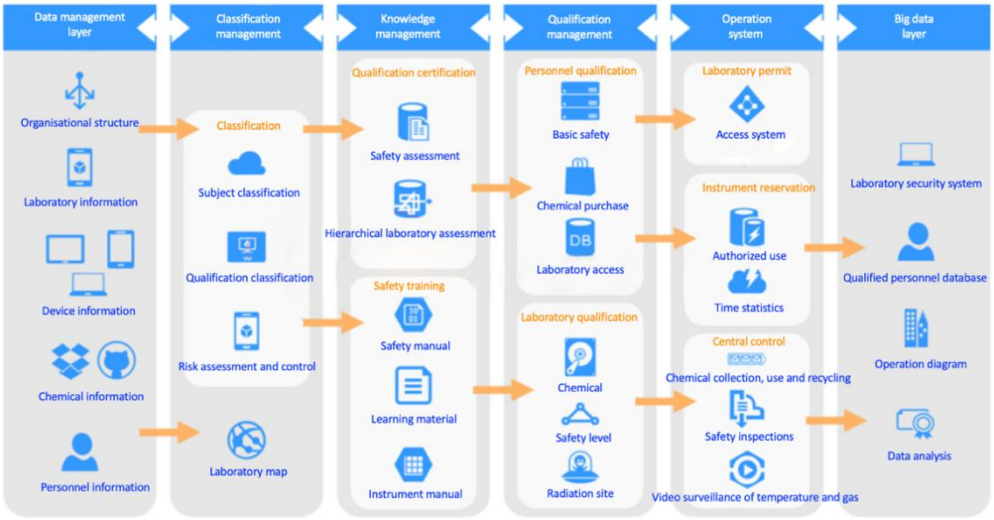

***Figure 5*: Framework of laboratory management system**
(Source: adapted from Join-Cheer, 2024)

As for data management, it includes the information of organisation, laboratory, device, chemical and personnel of BTBU. The system provides a more reliable method for classification which makes data more valuable including the classification of subject, the qualification of users and the risk grade of labs to optimize the distribution pattern of the system structure (Join-Cheer, 2024). The system can automatically update knowledge database including qualification and safety requirement of laboratory to realize standardized management. The qualification management system provides the standards of users and experiments, which is the key to operate the whole laboratory system. In terms of the operation system, face recognition technology is used for identity verification in the access control system of laboratory to increase safety. Moreover, the system collects information of the reservation of instruments. In addition, sensors collect the data of the laboratory environment, and then the system analyses the data to identify useful information for administrators (Mukhopadhyay et a., 2021). With regard to big data, Natural Language

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Processing is used to extract and process information from data to determine the meaning of texts including qualified personnel database and laboratory database (Pons et al., 2016).

In terms of online service platform of BTBU which is also supported by 'Handheld BTBU', an application of the simplified version of online service platform, course selecting system makes full use of AI technologies. The main interface of course selecting system is shown in figure 6.

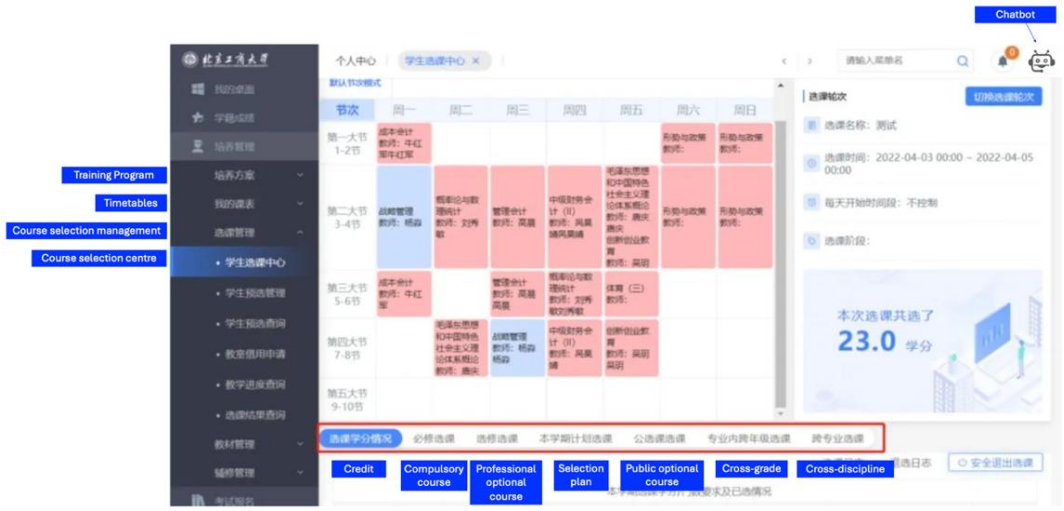

***Figure 6*: Course selecting system**

(Source: adapted from School of E-Business and Logistics of BTBU, 2023)

The course selecting system can recommend suitable courses for different students. The system analyses the data of both students and courses including learning records, interests, career goals, course descriptions, syllabus and feedback to match students with courses. In terms of course selection centre, the course types can be divided into five categories. To be more specific, students must complete compulsory courses as part of their degree requirements which have been arranged automatically by the system. With regard to professional optional courses, the system has made an individual selection plan for students based on their own situations and training programs which can be used as a reference for them. The system gives suggestions for public optional courses based on students' interests and goals. Outstanding students can select advanced courses and the courses of other professions.

By clicking the button in the upper-right corner of the page, students can communicate with the Chatbot which answers questions about course selection and sends out messages instantly so that they can collect ideas of themselves to find a more suitable course selection plan (School of E-Business and Logistics of BTBU, 2023; Crown et al., 2011).

]The course system can identify scheduling conflicts in timetables and suggest alternative courses for students. It can also monitor the capacity of each course in real time and notify students of over-enrolment and under-enrolment to ensure the success of enrolment.

Assessment and evaluation

BTBU has its own evaluation system of teaching and learning for students and teachers. Take the case of student clients shown in figure 7. Students are evaluated by teachers and

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classmates at the end of the semester. The system generates final scores and consolidates all comments into detailed reports based on the student performance and teaching effectiveness which can be downloaded by clicking on 'Score'. It also provides students with personalized recommendations based on the reports to help clear their own strengths and weaknesses which are in the section of 'Notes' (School of E-Business and Logistics of BTBU, 2023; Hussain et al., 2018).

***Figure 7*: Teaching and learning evaluation system for student users**
(Source: adapted from School of E-Business and Logistics of BTBU, 2023)

BTBU also uses the Data Monitoring Platform of Higher Education Quality for assessment and evaluation which offers the powerful functions of data collection, data processing and data statistics for all HEIs in China (Academic Affairs Office of BTBU, 2023b; Education Quality Evaluation Agency of the Ministry of Education, 2024a). The platform provides not only the reports about teaching level evaluation of teachers and the internal quality within the institution but also the discipline evaluation. As for each higher education institution, the evaluation data in the platform is classified into eight categories: basic information of the institution, the fundamental condition of the institution, faculty and staff information, student information, personnel training, disciplines, teaching and learning management and teaching quality monitoring (Education Quality Evaluation Agency of the Ministry of Education, 2024b).

Analysis and prediction

BTBU releases statistical and analytical reports of the employment quality of undergraduates every year. Take the case of the undergraduates of 2023 (Admissions offices of BTBU, 2023b). The report analyses the general information about the undergraduates, the quality of employment and employer's comments which can provide more information about the students' abilities and employment trends with the aim of improving curriculum construction and career services (González-Romá et al., 2018; Admissions offices of BTBU, 2023b). In

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this way, the system can also give suggestions about customized career directions and plans to the undergraduates.

The AI system provides the report of freshmen every year through the training model which has the analysis function of the data of freshmen. The model can identify the birthdays which are same with other students or the important festivals and the duplicate names of students (BTBU, 2023). As for the results of birthdays for the class of 2023 shown in figure 8, the system identified that there were 12 freshmen who were born on National Day and 13 freshmen who were born on Party's Day. Moreover, August 30 was the day that 19 students were born on which was a special day. In terms of name analysis shown in figure 9, the system identified that 'Han Wang' and 'Siqi Wang' were the two most popular names and 'Jia' was the most popular word among all freshmen.

***Figure 8*: Birthday analysis**
(Source: adapted from BTBU, 2023)

***Figure 9*: Name analysis**
(Source: adapted from BTBU, 2023)

As for prediction systems, Chen et al. (2023) created a system for the prediction and visual analysis of undergraduates' first destination based on Deep Learning, Causal Inference and Information Visualization. The operation procedure of the system and the prediction results about the students who were graduated from 2016 to 2022 and majored in Information Engineering are illustrated in figure 10. To be more specific, the user uploads the academic

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performance data of undergraduates in Part A. The probabilities of master's degrees, abroad, employment, freelance and unemployed of every student are shown in part B. Part C demonstrates the relationship between academic performance and the first destinations. Part D shows the prediction results in the forms of a table, a pie chart and a line graph.

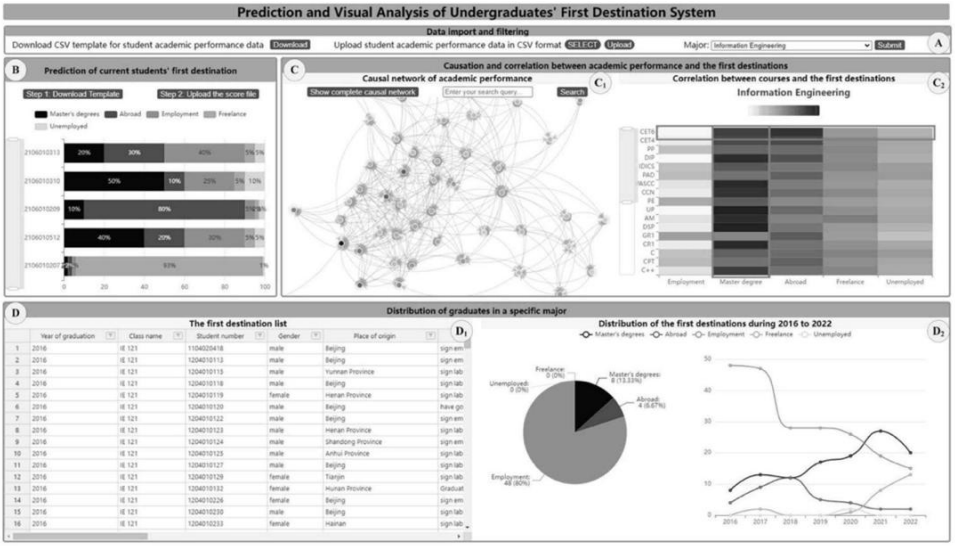

***Figure 10*: First destination prediction of Information Engineering undergraduates**
(Source: Chen et al., 2023)

Conclusion

AI can be used in both the delivery and management of teaching and learning which include the applications of two kinds of systems: intelligent tutoring systems in smart classrooms and adaptive systems for laboratory and course management. Moreover, AI technologies can assess and evaluate teaching and learning processes. It can also analyse the data of freshmen and graduates and predict the results for education.

However, there are still limitations that should be improved for this research. It is necessary for a university to compare the implementation of AI with other HEIs to identify its own areas for improvement and conduct more joint research on the development of AI. Furthermore, most studies of AI in HE are conducted in middle-income countries or high-income countries which have technological strength including this study. It is better to think about how AI can be used in higher education in other countries. In addition, nearly half of the research on AI in HE including this research just focuses on the school of engineering in a university since these students and teachers know more AI technology knowledge. It is recommended to expand the implementation of AI to all students and teachers in a university to help improve the efficiency and effectiveness of teaching and learning across the university. Besides, this research is just on the basis of higher education. Wider research can be conducted from kindergarten to university.

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Conflict of Interest

The authors declare no conflict of interest.

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