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Abstract

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Keywords

pandemics, online teaching, online learning model, higher education in China, pandemic

Revisions

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Online Teaching and Learning at Chinese Universities During COVID-19: Insiders' Perspectives

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Abstract

During attempts to prevent and control the COVID-19 pandemic in China, higher education programs shifted their traditional educational models to online models. This paper aimed to explore how Chinese universities organized online teaching and learning during the pandemic. It investigated the factors affecting the implementation of online teaching and provided policy recommendations for improving the quality of education in the post-pandemic period. The primary data for this study came from in-depth interviews with nine students and five teaching and administrative staff at eight major universities in mainland China. Literature was obtained in both English and Chinese from January 2020 to September 2021. Peer-reviewed journals, policy reports, and university documents regarding online education in Chinese universities were reviewed, and their challenges and countermeasures were investigated. The paper found that the implementation of online education was affected by various sources, including technologies, teachers' teaching skills, network information literacy, and students' learning motivations and self-directed learning skills. Based on the insiders' views, the paper suggested that to promote the quality of online education in the post-COVID-19 pandemic, higher education institutes and programs could develop their infrastructure construction, improve teachers' quality of teaching, and focus on students' learning motivations.

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Introduction

During the COVID-19 pandemic in China, higher education programs shifted their traditional face-to-face educational models to online models. Millions of schools in over 165 counties were closed. By the end of March 2020, about 1.5 billion students had been influenced by the reaction to the pandemic (Ministry of Education of the People's Republic of China [MOE], 2020a). To prevent and control COVID-19, on January 29, 2020, the Ministry of Education of China issued a notice entitled *Notice of the Ministry of Education on the postponement of the spring semester in 2020* (MOE, 2020b). This notice required colleges and universities to postpone the opening of the spring semester. It also encouraged administrators and teachers to take advantage of online platforms to

continue their teaching and learning activities without suspending classes. The Chinese colleges and universities actively responded to the call and uniformly adjusted their teaching from face-to-face to online for the spring semester of 2020, and quickly built a national emergency education service system. In spring 2020, all Chinese undergraduate programs implemented an online education model. According to the MOE, over 1.08 million teachers offered 1.1 million courses. The number of students who studied online reached 22.59 million. Teachers' acceptance rate of online teaching reached 80%, and students' satisfaction rate reached 85% (MOE, 2020c).

Online education is not a new concept. Since the Internet was invented, people have tried to apply modern information technology to teaching and learning to transform traditional face-to-face teaching models into online models. Current debates on technology-based education and online teaching and learning have focused on whether we should trust technology as a medium for enhancing individuals' teaching and learning activities (Montebello, 2018). How do technology and online tools impact teaching and learning? Could online education replace traditional teaching models? While scholars predict radical disruption in higher learning (Tapscott, 2014), discussions also highlight limitations in university online teaching and learning. Scholars have discussed the institutional challenges involved, including the lack of support for online teaching and learning (Bovill, 2016), the constraints to the use of online platforms from teachers' perspectives (Ohan & Chukwuone, 2018), and students' experiences and challenges in different kinds of online courses (Humphrey & Wiles, 2021).

This research explored how Chinese universities organized online teaching and learning during the pandemic, analyzed the factors affecting the implementation of online teaching, and provided policy recommendations for improving the quality of education in the post-pandemic period. Based on nine students and five teaching and administrative staff, as insiders, at eight universities in mainland China, this paper generalized the situation of implementation of online education in Chinese colleges and universities during COVID-19 and investigated the influencing factors of the implementation effect of online education to propose corresponding solutions for effective promotion of online learning in the post–COVID-19 pandemic.

Literature Review

During the COVID-19 pandemic period, researchers and educators started to have ongoing discussions in analyzing the role of online teaching and learning in the rapidly changing world (Dhendup & Sherab, 2023; Thacker-King, 2023). Based on previous literature, the researchers found that scholars examined online teaching and learning in China's higher education system in the context of COVID-19 at the macro, meso, and micro levels. Among them, the macro-level research focused on analyzing the impact and challenges of COVID-19 on higher education courses and teaching, national, regional, and organizational policy responses, and analysis of future trends in online education (Du, 2020). The meso-level research mainly examined the reform practices of universities, including adult universities, vocational colleges, ethnic colleges, medical colleges, military academies, and Sino-foreign cooperative education institutions (Zou et al., 2022). The micro-level research mainly focused on the practices of specific courses, analysis of the behavior of teachers and students, and the construction of online teaching platforms (Li et al., 2021b). According to previous literature, online teaching and learning in Chinese higher education has focused on three major aspects, including:

1. The construction of online teaching platforms,

2. The perspectives of teachers and students; and
3. The online teaching models and course contents.

First, the pandemic prompted universities to change their traditional face-to-face teaching and management models for student affairs and to develop various online teaching platforms further and appropriate teaching tools (Liu et al., 2020a; Zhang et al., 2020a). Related research included introductions to the design and application of the Peking University teaching network and Tsinghua Education Online teaching platform (Li, 2020; Li et al., 2021a); analysis of online teaching services and quality assurance systems in universities and the construction of intelligent teaching ecology (Lai & Peng, 2020; Wang, 2020); and the application of teaching tools and platforms such as MOOCs combining with the Tencent Classroom, and Chaoxing Fanya Platform combining with the Tencent Classroom (Pan & Yao, 2020).

Second, as the teachers and students moved from offline to online, they experienced challenges. Studies have found that COVID-19 has changed the requirements for teachers' roles and professional skills. Teachers were expected to adapt and adjust their teaching skills in order to meet the requirements of the new online teaching and learning environment (Wang & Wei, 2020; Zhang, 2021). Many scholars focused on learning outcomes in the online environment and analyzed the acceptance rate of online education and active learning by asking the students' perceptions (Wang et al., 2021). Some studies paid special attention to students' behaviors in online learning, including students' silent behavior in class and students' learning pressure (Lv et al., 2021; Meng et al., 2021).

Finally, some scholars analyzed the practice of online course models in the context of COVID-19, including online flipped classrooms, blended teaching, webcast courses, asynchronous SPOC teaching, online seminars, SPOC+ class virtual community, and so on (Guo et al., 2021; Li et al., 2020; Liu et al., 2020b; Xu et al., 2021; Yu & Yan, 2020). In addition, some scholars also paid attention to the practices of specific courses, including biological experiments, music, Chinese medicine, and employment guidance (Deng & Chen, 2021; Su & Liu, 2021). Research focused on constructing online internship courses was also conducted (Dai et al., 2021).

Previous literature focused on three major aspects: the development of online teaching platforms, the experience of teachers and students, and online teaching models and course content. However, there was a gap in reviewing models and exploring challenges from the perspectives of both teachers and students. With a literature review and in-depth qualitative interviews, this paper explores how Chinese universities, teachers, and students participate in online teaching and learning during pandemics.

Methods

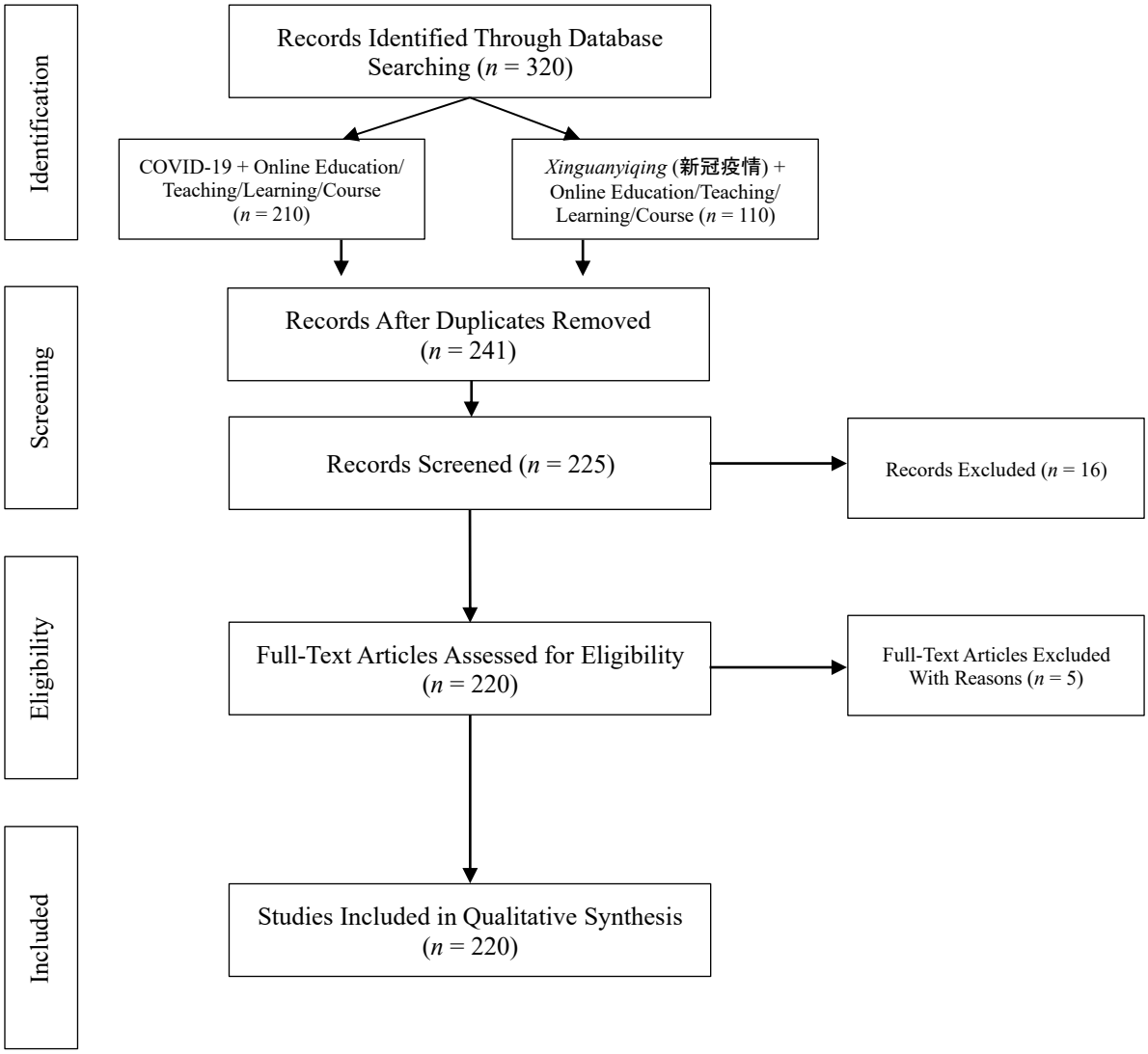
This study explored two research questions:

- What kinds of online teaching and learning models have been adopted in Chinese higher education?
- What kinds of challenges and countermeasures have Chinese higher education especially encountered during the COVID-19 pandemic?

Based on these two research questions, this study adopted two research methodologies, including a textual analysis of the literature and in-depth interviews from the insiders. First, the research

team used a literature review to sort out scholars' research topics on online teaching and learning in Chinese universities during the COVID-19. Papers from the China National Knowledge Infrastructure, a Chinese source database that is widely used in Chinese academic circles were collected. In this database, the authors collected publications in both Chinese and English related to online teaching and learning in Chinese higher education. All articles collected were research papers. News, social media articles, and/or other non-academic papers were not included. PRISMA was used to record the literature searching process (see Figure 1).

Figure 1. PRISMA Model of Literature on Online Teaching and Learning in China's Higher Education



Note. Xinguanyiqing = COVID-19

As shown in Figure 1, the combination of keywords searched by the research group was COVID-19 AND Online Education OR Teaching OR Learning OR Course, Xinguanyiqing AND Online Education OR Teaching OR Learning OR Course. Full text of papers that included the words *colleges* or *higher education* were included. In order to comprehensively cover the existing

research literature, the research team set the timeframe for the literature search from January 20, 2020, to September 25, 2021.

On January 20, 2020, Xi Jinping –General Secretary of the Chinese Communist Party, and Li Keqiang –Premier of the State Council of the People's Republic of China, gave important instructions on the pneumonia pandemic caused by the new COVID-19 and the State Council fully deployed the pandemic prevention and control work (Central People's Government of the People's Republic of China, 2020). At the time of publication, Chinese universities have begun to promote online education on a large scale in accordance with national requirements

In order to verify the literature and form a valuable supplement to it, this research adopted in-depth qualitative research for exploring online teaching and learning in Chinese higher education. Qualitative interviews helped provide in-depth insights and a rich understanding of the complex online teaching and learning practice in Chinese higher education, which allowed for collecting detailed information with students and teachers to uncover diverse perspectives and experiences.

The primary data for this study came from in-depth interviews with nine students and six teaching and administrative staff at eight universities in mainland China. The eight universities included Fuzhou University, Zhengzhou University, Beijing University, Beijing University of Technology, Hunan University, Anyang Normal University, China University of Mining and Technology, and Beijing Normal University. The selection of teachers and students from the eight universities in mainland China for interviews was aimed at capturing diverse perspectives and experiences to ensure a comprehensive understanding of online teaching and learning practices across varied educational contexts. A table containing demographic information of the participants can be found in Table 1.

Table 1. Demographical Information of the Interviewees

Identity	Gender	City	Major/Field of Work
Teacher	Male	Fuzhou	Education
Teacher	Male	Zhangzhou	Education
Teacher	Male	Beijing	Education
Teacher	Female	Beijing	English
Teacher	Male	Beijing	Mathematics
Staff	Male	Beijing	Teaching and learning
Student	Male	Beijing	Optical engineering
Student	Female	Beijing	Education
Student	Male	Xuzhou	Civil engineering
Student	Female	Beijing	Law
Student	Male	Beijing	Environmental engineering
Student	Female	Beijing	Education

In the interviews, the researchers asked the participants about their experience of online teaching and learning during the COVID-19 pandemic and their challenges and suggestions regarding online education in Chinese higher education. Each interview was conducted in Chinese and lasted for 45 minutes. The interview data was transcribed in Chinese and translated into English. Nvivo was used to code and analyze the data. The coding table included criteria of learning models, teachers' challenges, teachers' capacity, teachers' skills, students' learning motivations, hardware, software, and university facilities.

Findings

This study yielded two sets of research findings based on the qualitative interviews. The first research finding showed that Chinese universities had adopted various online teaching and learning models in their programs and curricula. Four major models based on the previous literature and our interviews were analyzed. The second research finding revealed that there were three kinds of challenges in terms of online teaching and learning in China's higher education system.

Implementing Different Models of Online Education in Chinese Universities

In general, Chinese colleges and universities encourage teachers to innovate teaching models. Many online education models emerged during the COVID-19 pandemic (Huang et al., 2020; Shang, 2020). In the following sections, four models were analyzed: the Massive Open Online Course (MOOC), the webcast model, the online task-based learning model, and the online seminar model.

The MOOC is an online education model that enables large-scale participation by students from all over the world. In a MOOC, course materials such as videos, readings, and quizzes are usually delivered through an online platform. MOOCs can be self-paced, meaning that students could complete the coursework on their schedule, or they could be structured with specific start and end dates and deadlines for assignments. The webcast model refers to the use of the internet to broadcast or stream live or pre-recorded audio or video content to an audience. The online task-based learning model was an approach to teaching and learning in which the teacher assigned clear learning tasks to students before a class. The students acquired the necessary knowledge through independent learning, with the teacher providing further explanations and answering questions during in-class lectures and interactions. The online seminar model helped students' engagement in discussions and brainstorming sessions with their peers and tutors through online communication tools, with the aim of mastering academic norms, clarifying research ideas, and solving problems encountered in the process.

Massive Open Online Course (MOOC) Model

The MOOC model refers to the high-quality courses on MOOC platforms organized by colleges and universities, whose resources, accumulated over many years, have played an important role during this pandemic. At present, the more popular MOOC platforms in China include MOOC China, Treenity, and iCourse. In recent years, the course construction of MOOC platforms has been relatively mature and complete, with a stable structure, abundant resources, and a variety of functions. During the COVID-19 pandemic period, the Ministry of Education actively promoted the construction and sharing of MOOCs and their platforms, resulting in a total of 41,000 high-quality online MOOC courses being provided with high-quality resources and collaborative teaching support (Huang, 2020). Online education with MOOC platforms has its strengths. For one, its asynchrony and repeatability allowed learning to be more free and flexible. One student interviewed said: "Teachers have recorded videos in advance so that we can learn whenever we want at a proper speed. What's more, we can pause and review courses many times when we need." (S6)

As an opportunity equalizer, MOOC allowed more students to enjoy rich and high-quality educational resources, expanded the scope of curriculum resources, and promoted educational equity. An Office of Academic Affairs teacher explained: "In terms of teaching quality, there is still a gap between our university and top universities like Tsinghua and Peking University. However, actively developing online education to introduce famous teachers' courses into our system could fill this gap." (T6)

Webcast Model

The webcast model is a model that allows teachers to convey knowledge to students in different locations in real time, through virtual classrooms. The virtual classrooms were built based on applications such as Ding Talk, Zoom, and Rain Classroom. This model was similar to the traditional face-to-face teaching mode. The only difference was that the teachers and students were in a virtual environment via the Internet. In a survey about the quality of online teaching in Chinese medical schools during COVID-19, the study showed that students believed the effect of live broadcasts was better than recorded courses or flipped classrooms (Zhai et al., 2020). In our interview, one of the teachers said:

> During the pandemic, online live courses have effectively replaced offline courses. As long as there is a network, you can take classes, which is more convenient for teachers and students. However, the actual effect may be different for each teacher. I personally prefer that all the students in the class turn on the camera and see how everyone is in class. (T3)

The webcast model had its own strengths of time synchronization, active interaction, and a strong sense of presence in teaching. The simultaneous live broadcast of the network was conducive to creating the collective atmosphere of traditional offline teaching, which might be in line with students' tendency to prefer traditional teaching models (Huang et al., 2020; Zhai et al., 2020). In addition, this model was characterized by active interaction. When the students experienced confusion, they could communicate directly with their teachers or classmates. Also, in this model, teachers could check students' learning while teaching through the video camera. Furthermore, since the function of webcast applications has improved, teachers can learn about students' studying status by using applications such as Rain Classroom and adjust their lecture schedule and teaching contents accordingly in order to improve the quality of their teaching.

Online Task-Based Learning Model

Online task-based learning meant that while the teacher assigns clear learning tasks to their students before a class, students can acquire the necessary knowledge based on these learning assignments through independent learning. Before the students started their assignments, the teacher provided lectures in class. The lectures were organized based on the students' self-learning course content. During the process of learning, the teacher further answered students' questions. For example, the School of Mechanical Engineering of Anhui University of Science and Technology in China had developed a teaching platform with a combination of the Tencent Conference and the Chaoxing Fanya. It provided some courses by setting up pre-class learning tasks. The students needed to master the course content through these learning tasks. The teachers provided explanations in class and actively interact with students (Zhang et al., 2020b). In Tianjin University of Traditional Chinese Medicine in China, some teachers provided high-quality course resources on their network platforms as the main source of asynchronous SPOC, and conducted

live broadcasting assisted by Tencent Meeting to enhance interactions between students and their peers and between students and their teachers (Li et al., 2020). This model was similar to flipped classrooms, but the pre-class and in-class teaching sections were all carried out online (Yu & Yan, 2020). In our interview, a teacher told us;

> My experience is not only to provide students with learning materials, but also to provide students with a study task list, and put forward clear learning requirements, so that students' learning will be more targeted and the learning effect will be better. (T4)

This new model completely changed the traditional teaching and learning models. On the one hand, it promoted the transformation from *teaching* to *learning,* aiming at building an online student-centered classroom. In this model, more attention was paid to the students' active exploration and their motivations in the discovery of knowledge. The role of the teacher was transformed from that of lecturer to organizer. Additionally, this mode combined the flexibility of asynchronous learning with the real-time interaction of synchronous learning in order to enhance students' learning and skills while dealing with questions about learning through synchronous communication and discussion.

Online Seminar Model

During the pandemic, some teachers advocated for research-based online teaching, and tried to add a discussion section to the teaching process in order to strengthen teacher-student interactions and improve teaching effects (Guo et al., 2021). The seminar model was widely used in online communication among scientific research teams. For example, various laboratories at Tsinghua University had carried out flexible and diverse online seminars during the pandemic (Huashan, 2020). The research teams utilized online communication tools in order to conduct brainstorming discussions around research topics or projects. Through guidance from their tutors and suggestions from their peers, students could master academic norms, clarify research ideas, and solve problems encountered in the process by using this model. During the pandemic, many research groups conducted online seminar models to overcome the limitations of isolation, which, for some content, reduced the impact of postponing sci-tech research. A graduate student expressed; "I think that through this duration of online seminar participant, I have strengthened the ability of independent research like proactive problem finding, conscious reading and thinking and knowledge accumulation" (S2). A third-year engineering postgraduate student said; "I would be more concentrated, mainly because the tutor would ask more questions to avoid our distraction. We can exchange more thoughts and ideas at the same time with higher efficiency and convenience in the online meeting" (S1). Both of these graduate students found the online seminar model very helpful for enhancing their independent research skills. The graduate students found that holding group meetings online helps to reduce their travel time and increase the time for online communication and discussion, which is effective for their learning.

Organizational Challenges of Online Teaching and Learning in China's Higher Education

This study revealed that although these models have been successfully adopted in Chinese universities during the COVID-19 pandemic, there were still challenges existing in online teaching and learning. Many surveys were conducted during the pandemic that showed that the evaluation of online education varies greatly among teachers and students (Mok, et al., 2021; Ren et al., 2021; Wu & Li, 2020). This study identified three kinds of challenges in online teaching and learning in

China's higher education system. These included basic challenges, key challenges, and discursive challenges. The basic challenges involved insufficient hardware and software facilities for online teaching and learning. The key challenges included teachers' capacity and skills for online teaching. The discursive challenges were mainly about students' learning motivations.

Basic Challenges: Insufficient Hardware and Software Facilities for Online Education

Since a good learning environment requires a good basis for online education, the carrier of online education is very important. Mobile phones, tablets, and computers became the mainstream learning tools due to their availability during the pandemic. However, many students from families with lower incomes did not have appropriate mobile terminal learning equipment or even access to the Internet, which resulted in negative online education effects because of the difficulty of full usage of various education media. A survey used in Xu's research (2020) showed that 88% of students from advantaged schools have computers for learning at home, but the proportion of students from disadvantaged schools is only 60%. Some families lacked an environment suitable for online teaching. Teachers and students were easily disturbed by family life and entertainment in their vicinity. Various family affairs could occupy students' energy and cause students' energy to be scattered. Moreover, most college students had not yet formed the habit of studying at home. (Kong et al., 2021; Zhang, 2020;). Only one student from a developing province said;

> The family financial situation of our students is generally poor. Although they all have mobile phones, only half of the students have computers, so mobile phones are commonly used in online classes, but the screens of mobile phones are relatively small, and sometimes we can't see the contents of the teacher's PPT [PowerPoint]. (S9)

A determiner of the effectiveness of online teaching and learning was the network coverage conditions. A survey showed that in China, 98% of students in advantaged schools can connect to the Internet at home, while the proportion of students in disadvantaged schools is 86% (Xu, 2020). As of March 2020, China's Internet penetration rate was 64.5%, while the Internet penetration rate in rural areas was only 52.3% (China Internet Network Information Center, 2020). It can be seen that there were still many areas in China that do not have a network coverage; for instance, network access in the West and in remote and impoverished mountainous areas was not yet fully covered. With such harsh conditions, it was difficult to support online teaching and learning (Ren et al., 2021). Most teachers had experienced online teaching being affected by network instability. Even a professor at Peking University (T5) dared not turn on his camera during class and just shared the PPT with students through the screen. In online learning, an unsmooth network with frequent freezes inevitably affects the learning efficiency of the students. Almost all students had similar experiences, and one student said in the interview;

> In online classes, the network is often unstable. Teachers often spend a long time debugging the network to ensure that the network is stable before they can start the class. However, the network will be unstable during the class, causing the picture to freeze or the voice delay. (S8)

The basis of online education implementation was the online teaching system. The foundation for ensuring the smooth progress of online learning was the stability of online education platforms (Wu & Li, 2020), whose information transmission quality was affected by factors such as physical bandwidth, throughput, and frame transmission delay. During the pandemic, a large number of student users squeezing into the network channel, which sometimes had exceeded the limitation

of a server's carrying capacity, resulting in tidal network congestion, which is why applications like DingTalk and Tencent conferences experienced overloaded *crash* situations.

Key Challenges: Teachers' Teaching Capacity and Skills

One of the key challenges for the online education system in China to achieve effective use of online education, was ensuring teachers had advanced online teaching skills and capacities. No matter the content or form, there were great differences between online education and traditional face-to-face teaching. In an era with both online and face-to-face teaching, teachers were required to not only have teaching skills, but also to master certain information technologies (Wu & Li, 2020). Teachers' familiarity with online education contents and methods had a direct impact on their curriculum development and the quality of their teaching. However, not all teachers had previous experience with conducting online education. For example, from January to March 2020, in the early stage of the COVID-19 pandemic, teachers needed to invest a great deal of time and energy to learning online teaching skills in order to open new courses on the teaching platforms in only a short period of time. Teachers had to quickly learn how to manage online classes, how to make micro-lectures through recording screens or editing videos, and how to interact with students during live broadcasts. However, many teachers could not fully master the online teaching skills, which meant that the methods of integrating technology into teaching and the effect of online teaching in Chinese higher education in the early stage of COVID-19 were not satisfactory (Ma & Zhu, 2021). Most of the students interviewed had encountered teachers who were not skilled in online technology and equipment, and one student told us:

> Some teachers are not familiar with the teaching equipment, which greatly affects the teaching effect. I was very impressed. The teacher was attending class at home. We were a two-hour class. As a result, there were two interruptions in class. The teacher debugged the equipment and spent half an hour each time. As a result, we only had one hour left in class. (S9)

In addition, during the pandemic period, some teachers had just moved offline lectures to online for some courses (He, 2020). In other words, the teaching form was still a one-way communication from teachers to students, and students were treated as passive recipients of knowledge. The offline teaching content was not completely suitable for online teaching, so that the teachers needed to integrate and optimize the traditional curriculum content to make it more suitable for the students' educational needs during the pandemic. Only content in line with teaching objectives, and matching students' cognitive levels, could really promote effective learning. For example, in a chemistry class, the traditional offline chemical experiments were switched to a software called as ChemLa for interactive chemical experiment simulation. However, since the teachers did not have good knowledge of the ChemLa learning software and good online teaching skills, the courses had not been well designed, which likely led to giving students a poor experience. One student pointed out; "We learned online courses that [the] teacher randomly has found on the Internet, and even has not improved them in combination with the actual situation. I feel that the teacher is very careless" (S3).

Finally, it was difficult for teachers to ensure that they have enough time and energy to learn online teaching skills, which greatly affected students' learning outcomes. Relevant research had shown that teachers' speed in providing feedback, the quality of their feedback, and their online tutorial input all impact students' learning (Peng, 2018). Teachers' appropriate supervision improved students' participation in the process of online learning. Under the situation that students have

stayed home for a long time and do not have a good learning atmosphere, the teachers' effective supervision is urgently needed for students with weak self-discipline abilities. During the pandemic period, typical tasks of online teaching, such as pre-class preparation, course explanation, assignment design, evaluation feedback, and analysis and summary undoubtedly had increased the workload of teachers.

Discursive Challenges: Students' Learning Motivation and Self-Directed Learning Skills

Throughout this research, it was found that students' learning motivation and self-directed learning skills could be seen as discursive challenges to online teaching and learning in China's higher education. Learning motivations could trigger, guide, and motivate individual learning behavior of online learners, which was very important to the students' learning outcomes (Wang et al., 2020). They were influenced by internal incentives such as learners' goal orientation, self-efficacy, and attribution, as well as external environmental factors. In addition, the high density and high frequency of online education practices might produce various internal and external factors that cause the decline or disappearance of college students' learning motivations. These learning motivations included negative emotions of pandemic panic and anxiety, low home-study objectives, and a sense of competition. A sophomore majoring in traffic engineering talked about his experience in a computer-aided design drawing class. He said;

> Although CAD [computer-aided design] and other drawing software is very useful, I did not learn it well because I have a lack of internal motivation during the pandemic. I don't think this software is so difficult, so I can learn it by myself when I need it (S7).

In previous studies, the researchers found that teachers generally believe that the pandemic requires students to be highly self-disciplined. However, because many students lacked self-discipline skills, their self-directed learning skills were quite low and need to be strengthened urgently (Wu & Li, 2020). Online education required the long-term use of mobile phones, tablets, laptops, and other devices, which were not only tools for learning, but also tools for entertainment. Some students with poor self-control could hardly resist the temptation of online entertainment in the absence of effective external supervision. One student (S8) recalled that once in a class, a student played an online game and forgot to turn off the microphone. Everyone heard the sound of the game.

Moreover, the effective interaction between students and teachers in online education was insufficient. In comparison with offline classrooms, students were generally more silent in online courses (Lv et al., 2021). In fact, communication tools such as e-mails, interactive communication platforms including WeChat, and social media provided ways for teachers and students to communicate. Through online learning tools, functions such as linking microphones, asking questions, and feedback were utilized, which helped to improve the level of interaction while shortening the communication path between teachers and students. However, in the online learning environment, students' perceptions of interaction were not high. This was mainly because Chinese students were used to passively participating in the classroom and were unwilling or afraid to take the initiative to ask questions in class. During the pandemic period, teachers and students had been isolated in physical spaces, so it was more difficult to arouse students' enthusiasm for participating in classroom interactions in the absence of their teachers' supervision and guidance and without their classmates' encouragement and drive. In addition, due to the large number of students in online course and the inappropriate proportion of teachers to students, it was difficult for teachers

to interact directly and frequently with each student. Two thirds of the students interviewed believed that teacher-student interaction in online education was not as good as offline education. One student said,

> I think online learning is not as effective as offline learning. On the one hand, when teachers ask questions, students generally do not respond or take a long time to respond. Everyone is accustomed to *diving.* On the other hand, the interaction between students is not enough. The teacher divided us into groups and let us discuss in groups. It is generally difficult for us to discuss effectively, and everyone doesn't speak much. (S9)

Discussion

During the pandemic period, based on infrastructure conditions, curricular characteristics, students' actual need, Chinese colleges and universities had continuously explored the implementation plans of online education. As a result, multiple online education models had been developed, each with its advantages, disadvantages, and scopes of application. Based on observations and in-depth interviews, the key to improving the quality of online teaching and learning while using these models is the teachers was found. With the MOOC platform, excellent teachers from universities across the country could share their courses with the students nationwide. Although the MOOC model could not provide immediate communication between teachers and students, it could provide excellent teachers with related course content and online learning materials for students from different disciplines. With the webcast model, teachers could design the most appropriate courses according to the actual level of the students. With this model, teachers could provide immediate interactions with students, which helped teachers to better understand the students' learning challenges and progress. In terms of the online task-based model, teachers' guidance and Q&A were based on students' independent preview, which could be a subversion of the traditional teaching-centered model. Therefore, this model had a high requirement for students' self-directed learning skills and poses challenges to teachers' knowledge storage and curricular preparation. The online seminar model comparatively focused on students' and teachers' exploration and thinking around a certain topic in the teaching process. Teachers (usually tutors) tended to enlighten students on their thoughts and helped them deal with academic problems through dialogue and discussion on the basis of knowing their academic progress, which was suitable for exploration activities in the frontier fields.

The four online education models from four elements are reflected in Table 2. They were technology tools, characteristics, main function, and applicable scale. Based on the literature and qualitative interviews, it was determined that the online MOOC model and the webcast model were applied in large-scale online education. The online task-based model and online seminar model were used in small-scale online education.

Table 2. Comparisons of the Four Online Education Models

Model	Technology Tool	Characteristic	Main Function	Applicable Scale
MOOC	MOOC platform	Asynchronous, open, structured	Imparting knowledge	Large
Webcast	Live broadcast	Synchronous, interactive, structured	Imparting knowledge	Large
Online task-based	Online communication application	Synchronous, asynchronous, autonomous, unstructured	Constructing knowledge	Small
Online seminar	Online communication application	Synchronous, interactive, unstructured	Constructing knowledge, frontier exploration	Small

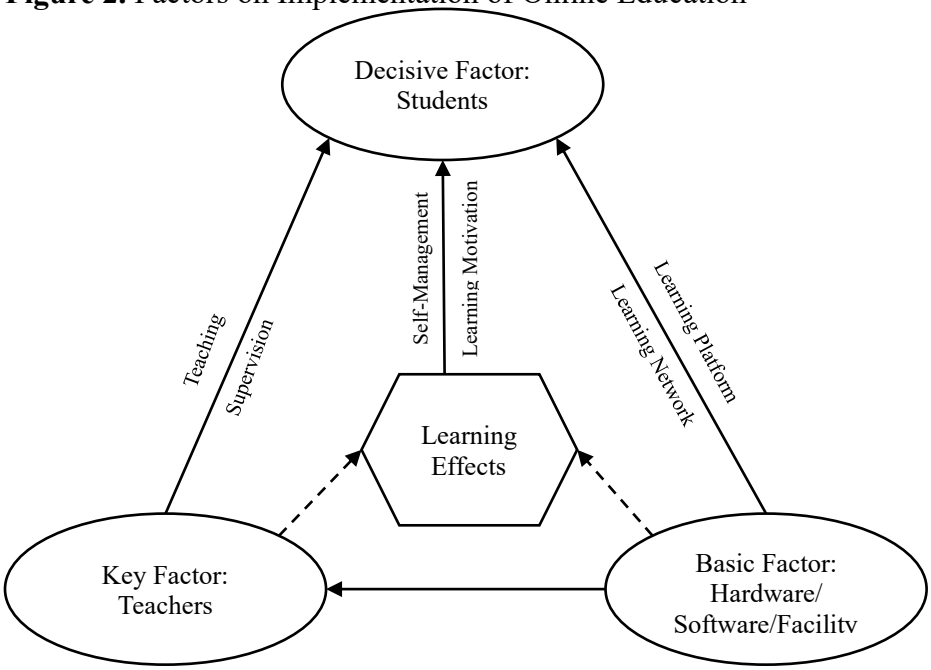
Under the influence of the COVID-19 pandemic, large-scale online education had posed challenges to traditional educational models. In comparison with the traditional face-to-face

model, students had acquired unprecedented spaces for autonomous study and self-regulation in online education. With the widespread application of information technology in higher education in China, online education became a basic demand for teachers, students, and universities. The universities had to think about how to quickly improve the information literacy of teachers and students in order to ensure the orderly development and management of online teaching and learning.

As mentioned before, there were various online education models, each of which came with different challenges. Overall, the challenges of the implementation effects of each model were similar. These challenges included technology-based teaching and learning conditions (e.g., network software, computer-based hardware), teachers' online teaching skills and knowledge of information literacy, and students' self-directed learning skills. Based on the literature review, qualitative interviews, as well as analysis and comparison of the four online teaching and learning models, this study proposed a model of factors that had affected the implementation of online education during the COVID-19 pandemic (Huang et al., 2020; Xie et al., 2020). Based on the findings, Figure 2 contains a depiction, which reflects how these three kinds of challenges (basic challenges, key challenges, and decisive challenges) were learning factors, including basic factors (e.g., hardware/software facilities), key factors (e.g., teachers), and decisive factors (e.g., students), that have affected the practice of online teaching and learning in China's higher education system during the pandemic.

As illustrated in Figure 2, hardware/software facilities served as a fundamental factor that directly impacted the teaching of teachers and learning of students by establishing a platform and network for teaching and learning. Students' learning occurred under the guidance and supervision of teachers and was directly influenced by them, while the actual learning outcome depended on the students themselves.

Figure 2. Factors on Implementation of Online Education



Note. Solid lines indicate direct impact, while dashed lines indicate indirect impact.

Basic factors, such as hardware and software, as well as key factors, such as teachers, were merely tools or external factors that assisted students in learning. Although they did not play a decisive role or directly affect the learning effectiveness of students, in the context of online education, students had to utilize these tools under the supervision and guidance of teachers to achieve more effective learning outcomes.

Conclusions

In this study, four models of online teaching and learning in China's universities were analyzed and found that the success of online education largely depends on the quality of teachers. Three kinds of challenges (basic, key, and decisive factors) that impact the implementation of online teaching and learning were identified. Finally, theoretical and practical recommendations for the government, universities, and individuals to improve the quality of education in the post-pandemic period were provided.

Theoretical Implications

This study contributes to the literature on Chinese online education in a global context. By providing a comprehensive analysis of the four online education models and their implementation, the findings highlight the importance of teacher quality in online education and the need to address challenges related to technology, information literacy, and self-directed learning skills. This study also proposed a model of factors that impact the implementation of online education, which can guide future research in this area.

In addition, this study provided insights into the challenges and opportunities of online education in the context of the COVID-19 pandemic in China's higher education system. By identifying the key factors that impact the success of online teaching and learning, the study offered important implications for researchers looking to improve the quality of online education in the post-pandemic era. The theoretical implications of this study could extend beyond the context of Chinese universities to provide valuable insights into the broader theoretical framework for online teaching and learning in universities during pandemics. The findings emphasized the critical role of teacher quality in navigating the challenges posed by uncertain circumstances such as the COVID-19 pandemic. The study highlighted the importance of adaptability, access, and equity in online teaching and learning in higher education. It shed light on the need for adapting flexible instructional models that could effectively overcome different levels of challenges caused by pandemics.

Practical Implications

During the pandemic, online education became a new normal, and there is still space for continuing development and improvement in the post-pandemic period. To optimize the implementation effect of online education and make it a new power and model for shaping future higher education, the researchers provided recommendations for online teaching and learning in Chinese universities on three levels: government, university, and individual.

At the government level, the construction of online education network infrastructure in China needs to be strengthened to ensure educational equity. The government should accelerate the construction of a high-quality education network based on 5G technology, develop more intelligent

online teaching tools with the help of big data, cloud computing, and artificial intelligence, and promote the work of online intellectual support to weaken the digital gap between urban and rural areas and between different families.

At the university level, it is necessary to increase investment in professional staffing and learning resources, provide appropriate training programs for different teacher groups to improve their online teaching skills, and strengthen the research and development and sharing of online education resources. Colleges and universities in China should also organize expert training meetings and teacher seminars to review the implementation of online courses, analyze existing problems, and put forward improvement strategies. To ensure a comprehensive approach to online education, universities should also support students in developing crucial digital skills and navigating online platforms effectively. This support could take the form of dedicated training sessions or workshops focused on enhancing digital literacy and proficiency in using educational technologies. In addition, universities could foster a sense of online community by facilitating virtual networking events, discussion forums, and collaborative projects to help students build social connections in the digital space.

At the individual level, professors/instructors/teachers in Chinese universities should strengthen their teaching reflection skills, optimize their education and teaching methods, and consider students' interest in and acceptance of different online education models when choosing teaching methods. Teachers can formulate targeted teaching strategies to provide effective support for learners' self-directed learning, cultivate students' self-directed learning skills, attract students' attention by building a lively and interesting course, give students clear supervision and guidance, strengthen the guidance and assessment of online learning behavior, pay attention to students' learning outcomes, communicate with students in good time, solve the difficulties in the learning processes of students, and assign a reasonable amount of tasks to students.

Limitations and Future Research

One limitation of this study is that it only focuses on the experience of Chinese universities during the pandemic. Future research could examine the implementation of online education in other contexts and countries, such as the United States, Australia, United Kingdom, Canada and some Asian countries. To enhance future research, a more systematic and comprehensive literature review is essential. Researchers could provide a scoping or systematic literature review for exploring online teaching and learning in higher education is recommended.

In addition, this study only focuses on the challenges of online education implementation; future research could also explore online education's benefits and collaborative opportunities. The benefits and opportunities of online education include enhanced accessibility and flexibility, personalized learning experiences, increased collaboration and global connectivity, expanded educational resources and materials, cost-effectiveness, and the potential for lifelong learning. Future research should delve into these aspects to provide a comprehensive understanding of the advantages and opportunities that online education offers. By examining both the challenges and benefits, researchers can contribute to developing and refining online education models and strategies that optimize student outcomes and address the evolving needs of learners in a digital age.

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