The Exploration and Practice of IT Solutions for Online Classes in Higher Education during COVID-19 Pandemic

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Abstract—Due to the COVID-19, the Ministry of Education of China announced that the 2020 spring semester will be postponed, on-site classes should be cancelled and schools should give online classes instead. It's the first time that online classes have been given priority to higher education, which is a new challenge to both schools and online learning platforms. It's necessary to carry out stable and efficient IT solutions to secure the smooth process of online classes. This paper takes South China University of Technology as an example to put forward some IT solutions and ways of improving teaching quality of online classes for higher education during COVID-19 pandemic.

Keywords—IT Solution, Online Class, Online Teaching Platform, COVID-19 Pandemic, MOOC

I. INTRODUCTION

Due to the COVID-19 outbreak, China's Ministry of Education (MOE) announced that the 2020 spring semester for all schools and universities would be postponed, which guarantees the public safety of students and teachers and curbs the spread of the virus on campus[1]. In support of this announcement of the MOE, some universities and colleges such as South China University of Technology (SCUT), held its spring semester opening ceremony online as planned on February 24. Most universities postponed their spring semesters or stuck to their scheduled school calendar forgiving online classes on March 2 and the following week in accordance with the follow-up announcement and guidance which issued by the MOE.

Such online teaching programs for undergraduate students and graduate students in formal higher education is a new challenge and have strict demands towards teachers and students, educational administration departments as well as educational technology centers, as they are different from distance learning, on-site classes or online-offline blended learning classes. When it comes to the quality of online teaching, one of the most important factors should be its IT solutions or the its online teaching system. A stable and efficient online teaching system can bring better teaching and learning experience for teachers and students. How to make sure that online classes are smooth and efficient during the outbreak? That is a challenge for universities like SCUT which have earlier 2020 spring semesters to take into consideration.

SCUT, for example, managed to minimize the impact of epidemic on education activities by actively conducting online programs for students at home to study.

II. MAIN CHALLENGES FOR ONLINE CLASSES OF HIGHER EDUCATION AMID COVID-19 PANDEMIC

As the whole nation begins to conduct online programs, main challenges for online classes of higher education amid COVID-19 pandemic are listed as follows:

A. the online system is not totally ready for the sudden transformation

Smooth network access is fundamental to online education. In the middle of February, MOE makes a further explanation that schools should not make students mandatory to study online, nor should it overwork teachers by requiring them to record every class; that schools should make good use of available high-quality online classes in school, local and national level at present; and that schools should conduct classes on a staggered schedule according to real-time circumstance. [2] However, there is a huge amount of both students and courses of primary, middle and high schools, colleges and universities in China. According to the statistics in 2018 there are 218,846,800 students in China, respectively 103,392,500 pupils, 46,525,900 junior high school students, 39,346,700 high school students, 35,598,700 students, 2,341,700 graduate students, and 389,500 doctoral students. [3] How can server pools of current teaching platforms support approximately 200 million visits at the same period? How many servers do you need at a(n) site/app for the number of users at that site/app for online classes during the pandemic? That is the first challenge to transfer real classrooms into online lessons.

B. None of online teaching platform has been put into effect on such a wide scale

In distance learning or mixed online-offline learning, it is common to use MOOCs (Massive Online Open Courses) and school-based online teaching platforms or LMS (Learning Management System) which usually allow tracking learning statistics and analyzing big data that automatically collected by the platform. The following are the advantages and disadvantages of these two kinds of platforms from the perspective of online tutoring.

1) The MOOC platform

Representatives of MOOC platforms in China include *iCourse*, *Xuetangx*, *Zhihuishu*, *Chaoxing*, and *UOOC* (University Open Online Course), etc.

Advantages. (1) MOOCs own rich learning and teaching resources initially. (2) Most MOOCs on popular MOOC platforms are free to university teachers during the COVID-19 pandemic. For similar courses, teachers can transform

MOOCs into SPOCs (Small Private Open Courses), and make some revisions to meet the requirements of their university, courses and students.

Disadvantages. (1) Of 12,500 MOOCs [4] in China, most are uploaded on multiple platforms with the duplicate content. The number of MOOCs is still insufficient for high education. (2) It is difficult for one platform to meet all needs of different levels of colleges and universities. (3) It is not an easy task for teachers who are non-tech savvy to accept this form of teaching immediately.

2) The School-based Online Learning Platform

Representatives of school-based online learning platforms include *Rain class*, *UMOOC*, *Chao Xing FanYa*, *Moodle*, *Sakai*, *BlackBoard*, *Canvas* etc.

Advantages. (1) It is customized to serve the faculty and students of one university with a student and faculty information system, an optimized server and even a database related to its original online learning and teaching resources. (2) With unified authentication (usually student or teacher ID) users can have easy access to assign or take corresponding courses as the platform is linked with the student and faculty information system.

Disadvantages. Some of the school-based online platforms are deployed on the university CERNET (China Education and Research Network, a Campus Area Network (CAN) in China). The CERNET is broad enough to cover the campus, but shares weaker internet signal when students connect it at home with external servers, like China Telecom. In addition, some of them are restricted to browse only on campus on account of information safety. Meanwhile, the number of live courses usually peaks at 8 am. It would cause instant shock to the internet server or even crashes if teachers conduct real-time interaction such as checking student's attendance. It is uncertain whether online learning platforms will manage such stress test. *Taobao*, with a ten-year running history, is a website with optimized servers that has managed to avoid overloads for several times. It can serve over 10 million viewers on *Taobao Live*, and counts to have over 100 million history viewers and more than 800 million users at 12 pm on November 11 which was called Double 11 shopping day (similar to Black Friday), the biggest online shopping day in China, 2019. [5] On the contrary, there were multiple times of video buffering, delaying or even server crashes on different online learning platforms within the last two weeks of February.

C. Not all teachers can tackle technical problems independently

It is impossible for every teacher to be savvy about Information Technology. A few teachers are not even proficient in the use of the Slideshow. While others, for instance young teachers who are largely born in the era of technology, are smart enough to present live courses on Tik Tok and other video streaming platforms instead of traditional online teaching ones.

D. Limited online learning resources

Students are scattered all over the country, even the world. And the network conditions are different. Some students living in suburbia would have difficulties in watching the tutorial videos due to poor internet signals. It is difficult to obtain learning resources, especially the written ones with copyright restrictions such as textbooks.

E. Network security

Network security problem including the privacy of teaching and learning data and resources, the safety and quality of online teaching and other issues should also be well considered.

III. IT SOLUTIONS TO ONLINE CLASSES FOR HIGHER EDUCATION AMID THE COVID-19 PANDEMIC

For universities that held its scheduled spring semester online, such as SCUT, everything seems to be in a race against time and pressure. On Feb 4, MOE issued the 2020 NO.2 Article [6] which requires universities to implement teaching plans in line with their reality and to place priority to keep online classes smooth and stable.

In view of the above challenges, taking the practice of SCUT as an example, the following IT solutions were proved to improve the stable and quality of online teaching after two months of trial. It mainly includes two aspects, respectively platform deployment and curriculum arrangement.

From the perspective of platform deployment, an accessible multiple option for school-based teaching system should be established. For teachers, it is necessary to develop the concept of "one online teaching plan for one lesson", and should have contingency plans in view of credit hours, platforms, network conditions of teachers and students and other different situations.

A. Upgrade the school-based online learning platform

The online learning platform at present is not originally designed for such large-scale online teaching and learning. Students are scattered all over the country, and almost all courses and all teaching classes are launched at the same time. It would bring huge traffic pressure on the platform server pool. University campus network backbone bandwidth should be upgraded to at least 10 Gigabit to meet the increasing communication use demands.

B. Turn on the "take-off" mode at rush hour

Take *Chao Xing* as an example. From 7:45 to 8:20 AM, the platform would switch on "take-off" mode to restrain massive data flow. All log-in users should wait on line to enter the classes. Students would not be able to upgrade their notes or group information, nor can teachers upload reference materials, check students' online attendance, nor start live broadcasting at that time.

C. Set a dedicated server to ease traffic pressure

Take *Rain class* as an example. Some universities, like SCUT, Have transferred all their course database in *Rain Class* to its subsite dedicated server *Rain Class: Yangtze River* which only runs for registered members, and its access user was controllable. From the first day of the semester till now, *Rain class: Yangtze River* has been providing stable and quick service to SCUT. Its performance is much better than the public-accessible *Rain class* platform.

D. Combine with social media platforms to provide diversified IT solutions, and to avoid information overloadand improve the quality of online classes

Some IT companies, like *Alibaba* and *Tencent* decided to offer free access of their education related apps to schools

during COVID-19 pandemic. On *Tencent Classroom*, teachers can share the screen to students. And students can "raise hands" to express their opinion and replay the lesson recordings after class for revision. The matting virtual background of *Zoom* can avoid the problem that the background is not appropriate to show in public when the teacher is having live-streaming courses at home. Moreover, live-streaming apps such as *DingTalk*, *QQ* Live and *WeChat for Business* have no limits on time of conferencing. Other live-streaming platforms like *Tik Tok*, *Douyu* and *OBS* which have better live-streaming experience and are more popular in public. They are suitable for teachers who plan to have classes open to public audience.

The group chat of *Tencent QQ* is the most popular application among students and teachers when it comes to online learning activities in that it has the most stable system and has the largest number of active users in China. Hence SCUT suggested every course should have a specific *QQ* group, then teachers and students could join in *QQ* groups for daily communication and interaction. Meanwhile, Tencent announced to expand the education relating IT functions of *QQ* group chat on February. Thus, it could be an alternative plan for online classes when online platforms go wrong. Table 1 shows how QQ group help teachers conduct teaching activities in different scenarios.

TABLE I. FUNCTIONS FOR ONLINE EDUCATION OF A *TENCENT QQ* GROUP CHAT

Online teaching application scenarios			**Functions module of *QQ* group in education**
Live broadcast	Network is smooth		Live with *QQ* + screen sharing
	Network isn't so smooth		Voice call + slideshow picture / screenshot
Self-learning with guidance	Students are mainly self-learning		Group files, Tencent documents
Answering, explaining, exercises, discussion and communication	Real-time and simple questions		Group messages (including: text, voice, short video, screenshot, screen recording, etc.)
	not real-time	Collect questions	Tencent documents
		Answer / Lecture	Group files, Tencent documents
Exercises and homework	Arrange and explain assignments		Homework, teacher assistant (Homework)
Teaching management	Sign in to class		Registration, teacher assistant (check-in)
	Collect message		Solitaire, voting, group collection (Tencent document collection form)
	Post information		Group announcement, receipt message, teacher assistant (notification), *QQ* group housekeeper
	Leave approval		Teacher assistant (sign off)

E. Provide safe and clean video recording and broadcasting room

Some faculty may have not suitable environment to do live broadcast or record video. Most of the universities have smart classrooms which have advanced recording and broadcasting system. Recording and broadcasting rooms should be sterilized thoroughly before and after teachers use it. Only one person is allowed to stay in one close-off classroom at one time. And teachers should make an appointment in advance to borrow smart classrooms on campus. The result of a survey on 123 respondents shows that students would be more attentive and concentrated if teachers conduct courses in the classroom on campus.

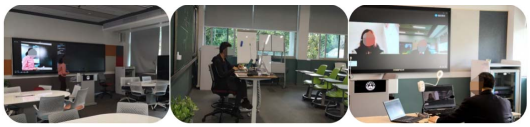

Fig.1. Record or broadcast classes on live in a smart classroom

F. Encourage teachers to develop their own online teaching plans

On the first week of the semester of SCUT there are near 2,800 online classes. About 45% of the teacher gave lectures on *Tencent* or *Alibaba* live streaming platforms, 25% of them chose MOOC/SPOC along with other platforms like *Rain Class*, *QQ*. Another 25% of them used the school-based online learning platform. Fig.2 shows differences of their choices in terms of the framework of IT solutions According to survey on 34 online classes in the first week of this semester, factors of the IT solution from most to least important in order are teachers' proficiency in tools, the stability and popularity of tools. Students would have better learning outcome if teachers make timely adjustments to their teaching plans to make better use of those IT solutions.

Here are five common online teaching models based on the survey results of 895 courses of SCUT in the first week in this semester:

(1) MOOC (micro video, discussion forum, assignment submission) + *Tencent classroom* live broadcast (assignment analysis, Q & A) + *QQ* group (notice).

(2) *Tencent classroom* live broadcast (assignment analysis, Q & A) + *QQ* group (notice) + online resources.

(3) *Rain class* (PPT with sound explanation or live broadcast) + *QQ* group (notice).

(4) *Tencent Conference* (live teaching, video interaction) + online teaching platform (micro video, homework, group discussion) + *QQ* group (notice).

(5) *QQ* group (homework module, sign in module) + *Tencent documents* (group work) + *QQ* screen sharing live + *QQ* group (notice).

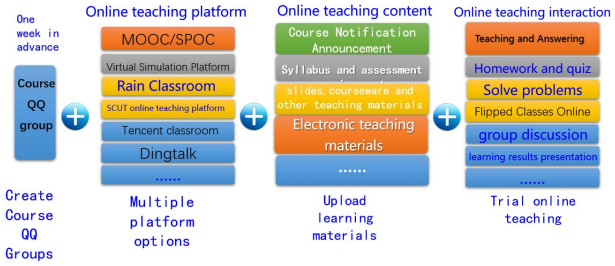

Fig.2. the framework of online education IT solution

IV. MEASURES FOR ONLINE TEACHING

The following measures are proved to effectively improve the quality of online teaching based on the practical experience of Educational Technology Center of SCUT (ETC) in this semester.

A. Offer coaching sessions of live-streaming courses to improve faculties' online teachingskills

The MOE stated that schools should offer online coaching sessions before giving online courses to help improve the quality and effectiveness of online education, given that it is also a novelty to most teachers. [7] The ETC of SCUT responded to the calls and played an active role in online training to guarantee the smooth progress of online teaching.

The training team of ETC of SCUT took the lead on January 31st to carry out online teaching training sessions, improving teachers' online teaching skills and techniques, and to set aside more time for teachers to prepare for online teaching. The training content is closely combined with theory and practice, including a total of four modules. Module one is basic techniques and methods of online teaching (basic methods of online teaching; design and practice of online teaching; topics such as design and implementation of online teaching based on school-based platforms). Module two is efficient online teaching with PPT. Module three is teaching mode sharing. Module four is online teaching case sharing. The coaching sessions are permanent available online. They are recordings or live videos made according to real scenarios happened on many school-based platforms.

The entire training incorporates IT solutions which were mentioned above, enabling faculties to understand the concepts and methods of online teaching and blended learning, master the use of online teaching platforms, resources and tools, and to make good use of modern educational information technology, curriculum resources, online teaching platforms, and online social communication tools.

The training courses online were well received by faculties in SCUT and other universities. For example, The 20th online lecture, Suggestion on Online Teaching during the COVID-19 Pandemic, hosted by Prof Lu Fang on XuetangX on February, attracted 213,000 online viewers and was extensively acclaimed.

B. Detailed tutorials on online platform operations

In order to facilitate teachers to fully understand the functions of each platform and master the application methods of the platform, and to help teachers with different levels of information literacy, nearly 40 detailed graphic and video tutorials which are consistent with the IT solution were compiled. All materials are shared nationwide along with application guides of the use of MOOC / SPOC and "teacher and student online teaching instruction manual".

C. Multiple online teaching and learning support

Although universities such as SCUT have accumulated a lot of experience in the construction and application of MOOCs, informatized instruction such as flipped classroom and blended learning, it is still a challenge for most counterparts. Multiple online teaching and learning support for faculty and student are quite necessary.

SCUT has established six online teaching and learning consulting *QQ* groups for faculties and students. Staffs from ETC of SCUT are responsible for answering questions from 7:30 am to 10:30 pm to assist faculties and students to solve technical problems in online teaching and learning.

Before the first online lecture, all teachers should conduct trial lectures in advance to make sure that the equipment, teaching resources are all stand by, and that all students have entered the class. After the rehearsal, almost all faculties were familiar with online teaching platform, and could quickly switch on the back up teaching platform to resume teaching when the original teaching platform went wrong.

At the same time, SCUT set up an online teaching inspection working group which comprises of 67 administrative members from Academic Affairs Office, Educational Technology Center， Guangzhou International Campus Teaching or Global Affairs Office and nearly 500 members who are the deans of different schools, deputy secretaries, or counselors. They would enter an online classroom randomly to conduct online surveillance as a way to ensure the quality of online teaching.

Most colleges and universities conducting online teaching have issued a "letter to all teaching teachers / students about online teaching/learning", held "the first lesson" of all teachers and students online, and held online videos conferences for undergraduate student and graduate student separately and student class meetings, to help teachers and students reach consensus on online teaching and learning with high quality and effectiveness.

D. Provide convenient and accessible online learning conditions to students

Almost all universities and colleges put forward collaborations with local Internet service providers in a bid to help students overcome technical or financial difficulties.

SCUT helped more than 2,000 undergraduates to apply for free Internet data packages of 30-100 GB/month. In total 2,099 students in SCUT received a special grant worth of RMB 1.51 million funded for fighting against the COVID-19. VPN (Virtual Private Network) service, eduroam and electronic text books were offered freely to student too.

E. *Join to enhance the ground online environment of online teaching and learning*

Schools, teachers, and students should comply with certain conventions. For example, the *QQ* group of all courses must be verified by real name to join, otherwise it will not pass. After entering the group, students should change their group alias if the teacher asks to. The alias is usually a student's name with his major. Chatting in anonymity is prohibited in every *QQ* group of online courses. During the lecture, screenshots may not be posted to the Internet without teacher's consent. Students need to protect intellectual rights and are not allowed to upload any learning resource in public Internet without permission.

V. CONCLUSION

For both online teaching platforms and higher education institutions, this kind of centralized online education means a novelty and fresh challenges. It's necessary to carry out stable and efficient IT solutions to secure the smooth process of online classes.

Online teaching has been running for more than two months, from February 17 to April 30 before the paper is submitted. In the first school week, there were 895 live-streaming courses, 2,337 online classes in SCUT, and 119,325 viewers. [8] SCUT made full use of the above online tutoring platforms, online learning resources, and educational IT solutions to improve the stability of online classes. According to the evaluation statistics from the surveillance group of SCUT, 90% of online courses in the first school week had high teaching performance. [9] Students were active in all kinds of online learning platforms.

The result shows an increasing number of learning activity data on many platforms within one week. For instance, the school-based online learning platform of SCUT only accounts for 7% of its teaching tasks this semester, but it had 28,791 visits in total. About 418 students' assignments were uploaded and totally 7,042 online tests were completed. On *Rain class*, 7,127 active users contributed 8,568 times of learning interactions and 413 teaching activities in 202 classes.

On live-streaming courses, students usually send "e-flowers" as a gift to teachers in order to express their gratitude. A student said that although they couldn't meet the teacher in person, the discussion boards of the teaching platform enable teacher to receive feedback in time, so that online communication can be carried out smoothly as well. Some student thought that they have more chances to interact with teachers, and also acquire more knowledge which meet their personal needs on online classes. It turns out that students are more willing to answer questions and interact with teachers online. [10]

Other colleges and universities also benefited from the MOOCs of SCUT. The user report of this ongoing semester to 13th April from main MOOC platforms were excerpted below. On *Zhihuishu*, SCUT provides 20 MOOCs in total. There are 29,500 students in MOOCs, and 69,800 students in 488 schools in SPOCs. And 72,870 students have subscribed lessons with credit hours. Users of SCUT have made 220,000 times of learning interactions in the first two weeks. On *iCourse*, SCUT provides 22 MOOCs in total, and there are 155,000 students in MOOCs and 7700 students in SPOCs.

The huge efforts to continue study online while canceling on-site classes made by SCUT was highly praised by several mainstream media including CCTV (China Central Television), GDTV (Guangdong Television), Guangzhou Daily, Yangcheng Evening News and Southern Net. The IT solutions to online teaching amid the COVID-19 pandemic of SCUT was awarded "excellent case of online learning for higher education" by Online Open Course Instruction Committee of Undergraduate Colleges and Universities in Guangdong Province.

We also found some problems within the two-month online teaching. For example, some students were yet not willing to take part in online class interaction. Teachers lacked online teaching skills and measures based on the ARCS (Attention, Relevance, Confidence and Satisfaction) model to motivate students to learn. Besides, whether teaching quality of online classes could be equivalent to on-site classes is yet to be investigated.

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