Evaluation and perception of online teaching of molecular biology using DingTalk for international medical students during the COVID-19 pandemic

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Abstract
The COVID-19 pandemic has greatly impacted the education of international students. The authors taught a molecular biology course using the DingTalk platform for international medical students (IMS) in the autumn semester of 2020. We assessed the effect of this online teaching based on an online questionnaire and by analysis of the final examination scores. Our findings demonstrate that the DingTalk platform is a free, effective and convenient online teaching tool for international students. The students' feedback showed that most of them were satisfied with this live teaching with DingTalk. They considered who viewed that the questions used in the live classroom setting were helpful for their learning. There is nonetheless still scope to improve this online teaching mode for international students, such as providing more pre-recorded teaching videos for offline application and use of a virtual simulation experimental molecular biology course. We hope that our findings regarding the experience of IMS with this teaching mode will be of value to other academic faculty.

KEYWORDS
COVID-19, international medical students, molecular biology, online education

1 | INTRODUCTION

The COVID-19 pandemic has had a huge impact on education systems worldwide, which has forced universities to convert traditional classroom-based teaching to web-based online teaching.1,2 In the recent years, the number of international medical students (IMS) has increased rapidly in China. Most of these students opt for a Bachelor of Medicine, Bachelor of Surgery (MBBS) program.3 This medical undergraduate program includes 5 years of theoretical and practical studies following by a one-year clinical rotation internship.4 This medical curriculum is based on regular basic medical courses (such as anatomy, biochemistry, molecular biology, physiology, pathology, and others) and clinical medical courses (such as surgery, internal medicine, pediatrics, gynecology, and others). The Chinese government has authorized approximately 100 medical institutions in China to accept IMS.5 The Xi'an Jiaotong University Health Science Center is the first university in China to have recruited IMS and carried out medical teaching in English for IMS. Since 1995, the Xi'an Jiaotong University Health Science Center has trained more than 3000 IMS from 63 countries. Our university devised the policies to control the quality of medical teaching for IMS in China, which is entrusted by the Chinese Ministry of Education.6,7

Molecular biology is a very important medical basic course that reveals the mechanisms of human diseases at
the molecular level. Molecular biology is a discipline employing various new technologies, which acts as a bridge between human diseases and medical research. Generally, even with the face-to-face classroom teaching, Chinese students find it hard to learn the contents of molecular biology course. Due to COVID-19, our IMS have had to remain off campus and stay at home for two semesters. At the Xi’an Jiaotong University Health Science Center, we have carried out online teaching of the molecular biology course for these IMS.

In order to meet the normal teaching requirements, teachers who plan to teach a course online need to carefully prepare and design the materials and methods for online teaching. At the Xi’an Jiaotong University Health Science Center, we chose the DingTalk platform to teach the molecular biology course for IMS in the autumn semester of 2020, based on our experience teaching Chinese-students online teaching with rain class. This was the first time that authors taught the molecular biology course online to international students. There is, therefore, an urgent necessary to investigate the perspectives of international students regarding this online teaching. We evaluated the effect of this online teaching with DingTalk by an anonymous questionnaire and by analysis of final examination scores, with the aim of adjusting and improving the quality of online teaching of the molecular biology course. We hope that our findings regarding online teaching of molecular biology for IMS will be of value to other academic faculty, especially for online teaching of IMS in China.

2 | MATERIALS AND METHODS

2.1 | Participants

The 2018-Grade IMS (students enrolled in 2018) at the Xi’an Jiaotong University Health Science Center were taught the molecular biology course online during the autumn semester of 2020. The final examination scores of 103 international students who received online teaching (2018-Grade) were compared with the scores of the 2017-Grade international medical undergraduates (students enrolled in 2017) who received traditional classroom-based teaching. At our university, IMS mainly come from developing countries, such as Pakistan, Nepal, Vietnam, Sudan, Kenya, Zambia, Kuwait, Tanzania, and other countries. These international students (enrolled in 2017 and in 2018) had the same teachers, the same syllabus, the same schedule, and the same previously taught medical basis courses.

2.2 | Implementation of the online teaching

The authors used the DingTalk platform to undertake online teaching of the molecular biology course for the 2018-Grade IMS, based on their spring-autumn experience of online teaching with rain class and Texun meeting for Chinese students. First, we established a class for the 2018-Grade IMS on the DingTalk platform named grade 18 MBSS. This class comprised all 2018-Grade IMS and all teachers assigned to teach molecular biology course, as well as the relevant teaching management staff. PPTs were uploaded to the DingTalk class in advance. Students also used other free online resources (including PPTs, Micro-Videos, and quizzes) to independently study molecular biology prior to the live teaching in the DingTalk class. The authors always logged into the DingTalk class 10 min before it was scheduled to start to ensure that the course ran smoothly. During the live teaching, the authors often asked several selected questions to ensure that students were paying attention to the teacher. The Dingtalk platform rapidly generated video playback after the live class, which was convenient, especially for those international students who did not attend the live class due to a time difference.

2.3 | Questionnaire

When this online teaching with DingTalk had been completed, an anonymous questionnaire was used to collect the international students’ opinions regarding this online teaching. These questions presented to the IMS were the following:

“What is your opinion regarding the online teaching of molecular biology in this semester?”
“Did you attend the live teaching of molecular biology on the DingTalk platform?”
“Were you satisfied with the voice effects of broadcast live with DingTalk?”
“Did network congestion affect your learning of the molecular biology course?”
“Did the questions presented by the lecturer during the live class help you to learn the topics covered in the molecular biology course?”
“Were you wishful to watch videos of the procedures when the teachers explained the methods of molecular biology, such as DNA cloning, real time PCR or others?”
“Do you think the time to learn molecular biology with DingTalk enough or not?”
“What is the main reason why you did not attend the live teaching of molecular biology?”
“Were you convenient to get access to the internet at your home?”
“What is the time difference between your home time and Beijing time?”
“Did you watch the video-playback on the DingTalk platform after live teaching?”
“Which is better for learning the content of the molecular biology course?”
“What is your opinion regarding this online teaching using the DingTalk platform compared with previous classroom teaching?”
“What is your opinion regarding this online teaching of molecular biology using the DingTalk platform compared with the online teaching of biochemistry in the spring semester?”
“Do you look forward to going back to campus and attending the experimental course of molecular biology?”
“Do you hope to perform DNA cloning, RNA extraction and real-time PCR in your experimental course of molecular biology when you return to campus?”
“Do you think it necessary to watch videos of procedures prior to your performing when you are able to return to campus, such as PCR, DNA electrophoresis and others?”
“Do you think it is necessary to have an online examination for molecular biology?”
“Please provide any recommendations or comments regarding online teaching of the molecular biology course.”

2.4 | Final examination

Finally, the 2018-Grade IMS took part in a web-based online examination when this course had been completed. The scores of these students who had online teaching (2018-Grade) were compared with the scores of the IMS (2017-Grade) who received traditional classroom-based teaching.

2.5 | Statistical analysis

The data are represented as means ± SD (standard deviation). The scores of the students who had online teaching (2018-Grade) and the scores of the students who received classroom teaching (2017-Grade) were analyzed by unpaired t-test. A p-value of less than 0.05 was considered to be statistically significant.

3 | RESULTS

3.1 | Characteristics of the online teaching with DingTalk

In the spring semester of 2020, our online teaching of the molecular biology course with rain class for Chinese students and the biochemistry course for international students both experienced serious network congestion. DingTalk is a free popular learning platform that can readily be used by students in China and in other countries. Our experience showed that online teaching with DingTalk presented several advantages. Firstly, it is a free and effective online teaching tool for international students. We were able to complete our teaching of the molecular biology course for IMS using DingTalk without experiencing any technical difficulties (Figure 1). We found that the live broadcast with DingTalk was much better than the live teaching with rain class and our campus network. Secondly, the DingTalk platform instantly produces video playbacks and provides a novice experience group in which teachers can adjust the volume many times by watching playbacks. Thirdly, the DingTalk platform readily accommodates for the communication between teachers and students. Our experience suggests that the use of selected questions in the live classroom setting was very helpful for IMS. The questions not only ensured that the students were paying attention but also let the teachers know what topics the students tended not to understand. According to the student’s answers, we could re-explain the topics that students tended not to understand.

3.2 | The questionnaire

To analyze the effect of this online teaching with DingTalk, the international students’ opinions were surveyed with an anonymous online questionnaire after completion of this course. The survey was answered by 83.5% of the IMS who had online teaching in this semester. The answers to the questionnaire showed that 38.71% of the
students were “very satisfied” or “satisfied” with this online teaching, but 43.55% of students rated it as “average,” and 17.74% of the students even rated “unsatisfactory” or “very unsatisfactory” (Figure 2a). The live teaching of the molecular biology course with DingTalk was “always” or “often attend” by 79.04% of the students (Figure 2b). The voice effects of the live broadcasting with DingTalk were considered to be “satisfied” or “very satisfied” by 53.23% of the students (Figure 2c). Network congestion “always” or “often affect” the learning effect of the online teaching of molecular biology course according to 53.22% of the students, and only 3.23% of the students indicated that network congestion “did not affect” their learning at all (Figure 2d). This feedback showed that instability of the Internet was one of the main impediments to international students’ online learning of the molecular biology course.

The majority of the students (69.35%) considered that the selected questions during the live lecturing were “helpful” or “very helpful” for their learning (Figure 3a). Watching videos of the procedures when teachers were explaining the methods of molecular biology, such as DNA cloning, was considered desirably by 72.58% of the students (Figure 3b). Nearly, half of the students (48.39%) thought that the time allocated to the molecular biology course was “obvious deficiency” or “a little deficiency” (Figure 3c). In terms of not attending the live teaching, 33.87% of the international students claimed that this was due to a time difference and 37.1% claimed that this was due to network congestion, while 17.74% of the students thought that video-playback was better than the live teaching (Figure 3d). Unexpectedly, as many as 43.54% of the international undergraduates stated that they did not have ready access to the Internet at home, which definitely adversely affects online teaching (Figure 3e).

The question about playbacks showed that the majority of the students made use of the playbacks to learn molecular biology to varying extents (Figure 4a). In terms of which is better for learning the content of the molecular biology course, there was not a clear preference (Figure 4b). Only 16.13% of the students considered that online teaching with DingTalk was “much better” or “better” than classroom teaching, 27.42% of the students thought that two methods were similar, and 45.16% of the students considered that this online teaching was worse than classroom teaching (Figure 4c). Face-to-face teaching has its advantages, such as direct eye contact, as well as interaction between teachers and students. This online teaching with DingTalk was “much better” or “better” than online teaching of biochemistry with the campus network according to 43.55% of the students, while 41.94% of the students thought that these two media were similar (Figure 4d).

The experimental molecular biology course for the IMS was delayed to the date when they could return to campus. The experimental molecular biology course is very important for medical students.16 The proportion of international students who “looked forward” or very much “looked forward” going back to campus and attending the experimental molecular biology course was 79.03% (Figure 5a). The proportion of international students who were “hopeful” or “very hopeful” to operate DNA cloning, RNA extraction and real-time PCR in their experimental course of molecular
biology when they could return to campus was 75.81% (Figure 5b). Watching videos of the procedures prior to performing was considered “necessary” or “very necessary” by 78.18% of the students (Figure 5c). Having an online examination of molecular biology was considered “necessary” or “very necessary” by 75.8% of students (Figure 5d).

**FIGURE 3** The opinion of the students regarding live teaching with Ding Talk. (a) Helpfulness of the selected questions; (b) wishful to watch videos of procedures when the teachers explain the methods of molecular biology; (c) the time allocated to molecular biology course was or was not enough; (d) the reason why students did not attend the live teaching; and (e) ready internet access at home.

**FIGURE 4** The assessment of video-playback and the effect of this teaching compared with other methods. (a) Watched the video-playback of molecular biology on the Ding Talk platform; (b) which is better to learn the contents of the molecular biology course; (c) opinion regarding this online teaching using Ding Talk compared with previous classroom teaching; and (d) opinion regarding this online teaching using Ding Talk compared with online teaching of biochemistry in the previous semester.
To assess the effect of online teaching of the molecular biology course with Dingtalk, the final examination scores of international students with online teaching (2018-Grade) were compared with the scores of the international students (2017-Grade) with traditional classroom-based teaching (Figure 6a). The 2018-Grade class had 103 international students who took this final examination, and the average of the scores for molecular biology was $83.83 \pm 0.7393$. The 2017-Grade class had 91 international students who took their final examination and the average of the scores was $58.97 \pm 1.148$ (Figure 6b). The scores of the 2018-Grade international students were statistically significantly higher than the scores of the 2017-Grade international students ($p = 0.0002$) (Figure 6b). Further section analysis of the final examination scores is shown in Table 1.

### 3.3 The analysis of final examination scores

To assess the effect of online teaching of the molecular biology course with Dingtalk, the final examination scores of international students with online teaching (2018-Grade) were compared with the scores of the international students (2017-Grade) with traditional classroom-based teaching (Figure 6a). The 2018-Grade class had 103 international students who took this final examination, and the average of the scores for molecular biology was $83.83 \pm 0.7393$. The 2017-Grade class had 91 international students who took their final examination and the average of the scores was $58.97 \pm 1.148$ (Figure 6b). The scores of the 2018-Grade international students were statistically significantly higher than the scores of the 2017-Grade international students ($p = 0.0002$) (Figure 6b). Further section analysis of the final examination scores is shown in Table 1.

### 4 DISCUSSION

The COVID-19 pandemic has had a huge impact on the global education system. The spread of COVID-19 worldwide enhanced the need for more medical practitioners in the society. Medical universities hence need to take more social responsibilities than before. It is very
important that medical universities maintain normal progress of teaching for medical students. Molecular biology is an important basic medical course for the students major in clinical medicine, as it provides an understanding of the molecular mechanisms underlying human diseases, thereby facilitating the development of novel diagnostic and therapeutic techniques, such as diagnosing COVID-19 infection. The outbreak of COVID-19 greatly enhanced the application of online teaching by universities in China. Currently, our IMS have been absent from campus for two semesters. It is also still uncertain how long the coronavirus crisis will last. Therefore, there is a real need to improve the online teaching of IMS.

There is no doubt that opinions from international students are the best source of information to improve online teaching. In the autumn semester of 2020, we carried out online teaching of the molecular biology course using DingTalk for international students, and we collected the perspectives of the international students. Most of the international students were satisfied with this live teaching with Dingtalk, and they considered the selected questions used in the live classroom setting to be helpful for their learning. Some of the students stated that the time difference and network congestion impeded their online learning. We found that international students were very keen to return to campus and have classroom-based teaching and perform the experimental molecular biology course. We anticipate that our international students will soon be back on our campus.

Presently, we do not know when it will be safe to allow students to return. It is, therefore, very important to establish a highly effective teaching mode for these IMS. Here, we found that 43.54% of the international students did not have ready access to the internet at home, which affected the live teaching. For these students, there is an urgent need to establish a teaching mode that is independent of the internet. The international students expressed interest in more videos being made available relating to the molecular biology course. In 2020, we did not have our own videos for this special-time online teaching. The students had to use open online courses resources for their self-learning. This feedback provided a direction for improving our teaching of the molecular biology course next semester. We need to prepare our own prerecorded teaching videos for international students, which can then be used offline. We should carefully devise teaching methods to match the interests of IMS. For example, students should be allowed to design how to test for the infection by the novel coronavirus using what they learned in the molecular biology course.

Next, we need to devise an English language virtual simulation experimental molecular biology course regarding technologies, such as DNA cloning, RNA extraction, and others.

Currently, approximately 75% of international students have been outside of China during the pandemic, and it is hard to predict when these international students will be allowed to come back to the campus in China. Therefore, it is very significant for teachers to communicate their experiences of online teaching in order to improve the online teaching for IMS in the future. We hope our experience with online teaching using DingTalk for IMS will be useful for other academic faculty.

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CONFLICT OF INTEREST
The author declares that there are no conflicts of interest.

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