

Implementing online teaching in universities during the COVID-19 pandemic: Experiences and lessons from China

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The unexpected COVID-19 pandemic in 2020 had a great impact on teaching for universities. In order to effectively prevent and control the epidemic, the Chinese Ministry of Education decided to postpone the opening of the spring semester in 2020, and required the implementation and guarantee of online teaching in universities during the pandemic prevention and control so as to achieve the goal of "suspending classes but not suspending learning". Under this specific background, the implementation of large-scale online teaching faced many challenges and opportunities. Taking the online teaching in the spring semester of 2020 in the School of Resource and Safety Engineering, Chongqing University of China as an example, this paper conducted an online survey among Bachelor students majoring in mining engineering and mining-related safety engineering at the end of May 2020. Based on the data from 226 questionnaires, the paper provided a statistical description and correlation analysis to explore the factors influencing the online teaching effects. The results show that the home online learning quality was mainly affected by gender, internet network, hardware, teacher-student interaction and students' independent learning ability. It is suggested that teachers can enhance the frequency of interaction and pay more attention to male students at online classes; universities can carry out training for teachers to improve their online teaching skills; and the education to improve students' independent learning ability should be strengthened.

INTRODUCTION

In order to prevent and control the spread of COVID-19 in a timely and effective manner, the Ministry of Education of China issued a notice on 27 January, 2020 to postpone the start of the 2020 spring semester. The Ministry put forward the requirement of "ceaseless teaching, ceaseless learning". Chinese universities therefore decided to switch from offline to online teaching to ensure normal teaching. Since 2012, the trend of online education represented by massive online open courses (MOOCs) has swept the world. By interspersing teaching videos with questions, in-class quizzes and thematic discussions, the communication, interaction and feedback in the online learning process was increased, making the open online education experience an explosive development [1]. However, compared with the number of user enrolment spurts, the course completion rate of registered MOOCs is only 5%. A large number of actual classroom videos are almost ignored, and the continuous click rate of many courses is very low. Even for students who specially receive online education, the online access duration of learning content made compulsory by the teaching unit is often difficult to reach the expected goal [2]. Until 2018, the teaching content of MOOCs was mainly distributed in public courses, basic courses, cultural courses, computer backbone courses and other fields, covering relatively narrow disciplines and majors, and the scale effect is still prominent. How to improve the teaching quality also needs to be studied [3]. The sudden outbreak of the epidemic disrupted traditional face-to-face teaching, leaving Chinese universities with less than a month to prepare for online teaching. Online education in China faces many challenges, such as the teaching target involves all students; all kinds of courses should be open; some teachers and students do not have online teaching and learning experience, so it is difficult to guarantee the teaching quality.

In a special context, this paper studies the factors that affect the efficacy of online learning. Taking undergraduates from the school of Chongqing University (CQU), China as an example, the paper compares the data analysis results with the existing researches by other Chinese universities, and provides suggestions for universities' online teaching in the future.

METHODS

This study used an online questionnaire survey. The survey samples were from the undergraduates of School of Resources and Safety Engineering of CQU during the period of COVID-19 in 2020 (February to May), in which students majoring in mining engineering and mining-related safety engineering accounted for about 50% respectively.

The questionnaire mainly included four parts: the basic information of the interviewees, the objective class situation, the subjective self-learning effect evaluation, and the feelings and evaluation of online/home learning. Except for basic information and multiple choice questions, most questions had four option - because Chinese students tend to choose from four levels, which helps students make more objective evaluations. The subjective online/home learning effect of the interviewees was the key question, and conclusions were drawn by comparing it with other questions.

A total of 276 questionnaires were collected, 50 invalid questionnaires were excluded, and 226 valid questionnaires were collected. The ratio of male to female respondents was 181:45. As a comprehensive university with dominant science and engineering majors, Chongqing University has a large proportion of male students, as shown in Table I.

Table I. Gender statistics of respondents

Gender	Number	Proportion (%)
Male	181	80.1%
Female	45	19.9%

Grade of the students interviewed: 38.1% of the subjects were freshmen; 35.4% were sophomores; 20.8% were juniors; 5.7% were seniors; as shown in Table II.

Table II. Statistics of grades of respondents

Grade	Number	Proportion (%)
Freshmen	86	38.1
Sophomores	80	35.4
Juniors	47	20.8
Seniors	13	5.7

Regarding hometown of the students interviewed: about 10.6 % undergraduate came from provincial capitals; 14.2% undergraduate from prefecture-level cities; 10.6% undergraduates from county-level cities; 28.8% undergraduates from counties and towns; 35.8% undergraduates from rural areas; as shown in Table III.

Table III. Statistics of hometown types visited

Hometown type	Number	Proportion (%)
Provincial capital	24	10.6
Prefecture level city	32	14.2
County-level city	24	10.6
County town	65	28.8
Rural	87	35.8

Use the following scale for rating the evaluation of the home online teaching effect, where 1 means bad; 2 means average; 3 means good; 4 means very good. Data were imported into SPSS software for analysis. Independent sample T test was used to analyse the learning effect of male and female students. Chi-square test was used for difficulties encountered in learning; single-factor ANOVA was used for the rest. LSD method was used for multiple post comparison. Games-Howell correction value was used for multiple post comparison if data variance was not uniform.

Results and Discussion

The main factors influencing the effect of online learning are gender, hardware and software facilities, teacher-student interaction frequency and motivation to solve difficulties. Females learn better online than males. In addition, the online learning effect is positively correlated with the frequency of teacher-student interaction and the enthusiasm for solving problems. For students, the difficulties affecting the effect of online learning include poor internet network, poor self-image and environmental changes.

The relationship between gender and learning from online/home

As can be seen from Table IV, the mean value of male students' learning from online/home are both lower than that of female students, indicating that female students have better learning ability than male students. There are significant differences in the online learning effect and home learning effect between genders.

In the variance homogeneity test, the significance p value is $0.123(0.057) > 0.05$. The hypothesis of variance homogeneity is rejected. It is necessary to check the result of 'not assuming equal variance' (i.e. the value in the second row of the sig. column). According to the test, the significance (two tailed) is $0.002(0.012) < 0.05$. The hypothesis that the case groups had different mean values was accepted, that is, different genders had different effects on online(home) learning.

In order to study the reasons for the significant differences in learning effect between men and women, the differences between gender and difficulties encountered in learning were analysed. According to the results of the analysis, gender does not show travel difference for the multiple choice with four items in total ($\chi^2=6.606, p=0.086>0.05$).

Table IV. Independent sample t-test of gender and the impact of learning from online/home

	Gender	Number	Mean	Std	Std error	Sig.	Significance
Online	Male	181	2.06	0.801	0.060	0.001	0.123
	Female	45	2.49	0.787	0.117	0.002	
Home	Male	181	1.96	0.773	0.057	0.012	0.057
	Female	45	2.29	0.869	0.130	0.012	

The relationship between teacher-student interaction frequency and the impact of learning from online/home

It can be seen from Table V that students with higher frequency of active interaction have higher mean option scores, and students with active interaction have a 'good' learning effect. This is because the interaction forms an active classroom atmosphere, in the process of equal communication between teachers and students, to improve students' learning enthusiasm, stimulate initiative and exploration of both sides of the teaching, and then realise the improvement of teaching effect.

There are significant differences both in online learning effect and home learning effect with different times of interaction. For online learning effect, there are significant differences between occasional active and almost no interaction, active interaction and almost no interaction, passive response and active interaction, occasional active interaction and active interaction. For the impact of learning from home, there was a significant difference between almost no interaction and occasional active learning.

Table V. One way ANOVA test of students' active interaction frequency and the impact of learning from online/home

		Number	Mean	Std	Std error
Online	Hardly	58	1.95	0.826	0.108
	Passive response	92	2.08	0.773	0.081
	Occasionally active response	70	2.30	0.768	0.092
	Active interactive response	6	3.17	0.983	0.401
	Total	226	2.14	0.815	0.054
Home	Hardly	58	1.78	0.727	0.095
	Passive response	92	1.98	0.756	0.079
	Occasionally active response	70	2.20	0.809	0.097
	Active interactive response	6	3.00	1.095	0.447
	Total	226	2.02	0.802	0.053

As can be seen from Table VI, the average score of student options in which teachers often actively interact with students is the highest, slightly higher than the 'average' level. Students whose teachers barely interact with each other had the lowest mean scores, not 'average'. The interaction between students and teachers has a great impact on teaching results. In addition, the difference between home and online learning scores was only 0.12. The possible reason is that both home learning and online learning are not under the supervision of teachers, so they have independent learning space and are freer.

There is a significant difference between the active interaction times of teachers and the impact of learning from online/home. For the effect of online learning, occasional interaction is significantly different from frequent interaction. In terms of the study effect at home, there were significant differences between almost no interaction, occasional interaction and frequent interaction.

Table VI. One way ANOVA test of the number of teachers' active interactions and the impact of learning from online/home

		Number	Mean	Std	Std error
Online	Hardly	16	2.13	0.719	0.180
	Occasionally	177	2.07	0.805	0.061
	Often	33	2.52	0.835	0.145
	Total	226	2.14	0.815	0.054
Home	Hardly	16	1.69	0.602	0.151
	Occasionally	177	1.99	0.790	0.059
	Often	33	2.36	0.859	0.150
	Total	226	2.02	0.802	0.053

The relationship between difficulty handling style and the impact of learning from online/home

As can be seen from Table VII, the students who are more active and find teachers and classmates to solve problems in time have higher mean option scores. Compared with teachers, students are more concerned about whether the interaction can get timely and effective feedback [4], and taking the initiative to solve problems helps students understand knowledge better.

There are significant differences between difficulty handling style and the impact of learning from online/home. There are significant differences between seeking teachers in time and ignoring them, asking questions in group and ignoring them, thinking independently and ignoring them.

Table VII. One way ANOVA test of difficulty handling style and the impact of learning from online/home

		Number	Mean	Std	Std error
Online	Ask the teacher in time	17	2.53	1.007	0.244
	Ask questions in the Learning group	97	2.20	0.745	0.076
	Independent thinking	82	2.15	0.833	0.092
	Ignore	30	1.73	0.740	0.135
	Total	226	2.14	0.815	0.054
Home	Ask the teacher in time	17	2.18	1.074	0.261
	Ask questions in the Learning group	97	2.08	0.759	0.077
	Independent thinking	82	2.07	0.782	0.086
	Ignore	30	1.60	0.724	0.132
	Total	226	2.02	0.802	0.053

The relationship between learning difficulties and the impact of learning from online/home

The cross analysis was used to study the cross relationship between the impact of learning from online/home and learning difficulties. For all students, regardless of gender, the analysis results showed that the impact of learning from online/home did not show any difference in the four multiple choice questions (Online: Chi =4.645, P =0.864>0.05; Home: CHI =6.267, P =0.713>0.05).

The Chi-square goodness of fit test was used to analyse whether the proportion of choices in learning difficulties was evenly distributed. As can be seen from Table VIII, goodness-of-fit test presents significance (CHI =28.295, P =0.000<0.05), which means that the selection ratio of each item has significant difference. The difference can be specifically compared through response rate or penetration rate. Specifically, the response rate and penetration rate of three items, namely poor network condition, poor self-image and environmental influence, were significantly higher.

Table VIII. Response rate and penetration rate of various difficulties encountered in learning

Option	Response		Penetration Rate(%)
	n	Response rate(%)	
Poor network condition	163	28.75	70.87
Difficult to communicate	87	15.34	37.83
Poor self-image	158	27.87	68.70
Vulnerable to environmental impact	159	28.04	69.13
Total	567	100	246.52

Goodness-of-fit test: $\chi^2=28.295$ $p=0.000$

Comparative analysis with existing research results

The frequency of teacher-student interaction affected the online teaching effect. Most students expressed that online discussion forms such as comment area and interaction area can stimulate their sense of participation in learning and promote learning, especially for teachers in western China, whose influence ranked in the top three^[5-6]. However, about 77% of teachers believed that online teaching lacks emotional communication and cannot master students' situation well^[7]. The survey results of undergraduate learning in the School of Physics, Peking University also showed that 62% of students felt that online teaching interaction was "significantly reduced" or "reduced", and only 16% choose "enhanced", indicating that teacher-student interaction had not achieved the expected effect^[8-9].

The smoothness, stability and speed of the network environment were important factors to ensure the smooth implementation of online teaching^[6], not only for students in Chongqing University. According to the statistics of Guo Yingxia^[5], students in western China ranked 18 factors affecting online learning effect according to importance, among which network speed and stability ranked the third. It showed that students in western China pay more attention to network speed and hardware equipment support.

In addition, university students in western China think the suggestions for improvement mainly include: improving the function and stability of the platform, improving the speed and stability of the network, and strengthening online technical service support. Even for the undergraduates of The School of Physics, Peking University in Beijing, internet connection was the most important factor affecting the effect of online learning, accounting for 22%. In the online learning problems selected by students, they ranked third, accounting for 21%^[8]. In addition to regional factors, poor network speed and stability was one of the most important problems for students in research, general undergraduate and vocational universities, and 54.94% of the students agreed with it ^[4].

Students' independent learning attitude and ability were important factors to ensure the smooth implementation of online teaching, especially in research universities, ranking first among 18 influencing factors ^[4,6]. Online learning can cultivate students' independent learning ability and innovation ability^[9]. The statistical results of 334 universities showed that 62.78% of students thought it was helpful to cultivate independent learning ability, which is similar to the result of Southwest University (61.7%^[7]) ^[4].

CONCLUSIONS

As can be seen from the above discussion, the impact of learning from online/home are mainly affected by gender, internet network and hardware, teacher-student interaction and students' independent learning ability. Male students have less self-control ability than female students. Male students are more playful than female students, especially when on computers. Online learning interaction between teachers and students has not fully reached the expectations. Before the outbreak of COVID-19, not many teachers had enough experiences with online teaching. Teachers were not familiar with the online interactive methods, which led to a certain decline in teaching effectiveness and still needed some time to adapt. It is suggested that teachers pay more attention to male students during online classes; universities can carry out online teaching methods training for teachers, improve their online teaching skills, and enhance the frequency of interaction between teachers and students, so as to stimulate students' interest in learning and improve the teaching effect. The independent learning ability of students needs to be improved. Students study online at home without the supervision of teachers in classroom. An unstructured learning environment causes students to be easily distracted, even scanning mobile phones. Finally, the future study should be conducted in understanding students' psychological features and stress under the specific epidemic with remote online teaching.

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