Research article

Chinese digestive surgery interns' learning quality and English reading proficiency during COVID-19 pandemic: Comparison between face-to-face versus WeChat teaching and learning☆

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A R T I C L E   I N F O

A B S T R A C T

Gastrointestinal clinical teaching is of vital important for gastrointestinal surgery interns. However, during COVID-19 pandemic, due to frequent lockdowns and essential social distancing policy implemented in China, face-to-face teaching was interrupted significantly. To find a cost-effective way to deliver medical education to ensure that teaching and learning would be continued and uninterrupted, many social media tools and mobile applications have been used in medical teaching and learning. WeChat has been frequently employed in teaching and learning in many disciplines in Chinese universities due to its powerful functions and free cost. This study compared Chinese digestive surgery interns' learning quality, English reading proficiency, and learning satisfaction in two teaching conditions: the traditional face-to-face teaching versus WeChat teaching via an experiment. The study recruited 60 final year clinical medical students, who were randomly and equally assigned into two groups: traditional face-to-face teaching versus WeChat teaching. Interns' learning quality and learning satisfaction were measured by Likert-scale questionnaires; and their English reading proficiency was measured by the reading section in a standardized English test. The results showed that interns in WeChat group had significantly higher learning quality on understanding mechanisms and current knowledge by both self-assessment and peer-assessment. WeChat group also outperformed face-to-face group on inferencing, details, and main ideas in English reading. With regard to learning satisfaction, WeChat group were higher on learning interests, learning objectives, learning format, and English reading proficiency than face-to-face group. However, interns did not differ in terms of their learning satisfaction on medical skills, which might indicate that WeChat had limitations on training interns' medical practical ability.

1. Introduction

For medical students, clinical practice is an important stage of transforming clinical knowledge into practical ability and a key process for them to become doctors, playing a vital role in the whole medical education process [1]. General surgery is the largest specialty in the surgical education system, covering most of the knowledge and operating skills of surgery [2,3]. As an important branch of general surgery, gastrointestinal surgery covers wide diseases, complex physical examination operations, and high misdiagnosis rates [4]. The gastrointestinal surgery department also covers emergency and critical medicine and trauma surgery [5]. It requires medical students to possess advanced medical knowledge and high standard operation skills, often being one of the most difficult clinical trainings for medical students [6]. Gastrointestinal surgery training helps improve other essential skills for medical students, such as clinical thinking ability, and lays a foundation for further study of other specialties [7].

Apart from clinical training, English reading proficiency is also important for medical interns in China as English is considered as the key to their academic advancement for medical interns, who are highly like to pursue further graduate studies, such as Masters' and Doctorates' degrees after completing clinical practice [8]. The post-graduate entrance exam and the doctoral entrance exam for Chinese medical students place significant emphasis on English reading proficiency, especially English reading proficiency. Additionally, cutting-edge information and knowledge in the medical discipline are frequently communicated in English, which requires students to be equipped with sufficient English reading proficiency to update their knowledge to keep abreast with advancement in medical sciences and skills. Medical students also need to read English journal articles and are expected to disseminate their research findings in English in their study journeys or in their future careers [9–11].

In early 2020, a novel coronavirus pneumonia outbreak occurred worldwide and spread rapidly [12]. The continuous spread of the pandemic brought great challenges for universities worldwide, including medical schools [13]. The policy of no suspension of classes proposed by the Chinese government promoted a rapid transformation of education to online teaching and learning, which ensured learning to be continued and uninterrupted throughout the lockdown periods. As a result, online teaching and learning have become the primary means to deliver education in China since late February 2020 [14].

Due to such emergent and large-scale transformations, many social media tools and mobile applications have been integrated into teaching and learning because of their lost cost (sometimes free of cost) and ease of access by the vast majority of Chinese students. In China, the most popularly used social media application is WeChat and it is estimated that the number of WeChat users is over one billion around the globe [15]. WeChat is available on Android, iPhone, BlackBerry, and Windows and is supported by Wi-fi, 3G, 4G, and 5G data networks. It covers more than 94% of Chinese smartphones, with 806 million active users per month, and is available in more than 200 countries and in more than 20 languages. WeChat has five main functions: 1) sending voice messages, videos, pictures (including facial expressions) and texts; 2) multi-group chatting; 3) video chatting; 4) mailbox, voice notepad, and other plug-in functions; and 5) used as interphones [16].

Previous studies have shown that social media tools are used in various medical contexts, such as helping people get medical consultations, helping patients communicate with doctors, and obtaining immediate medical assistance [17]. In Western countries, WhatsApp has been adopted in medical education in colleges and universities and has achieved a great success [18]. Similarly, in China, WeChat has been frequently used in Chinese medical education in recent years to supplement face-to-face teaching and learning. In general, past studies have demonstrated positive effects of using WeChat on learning quality and students' learning satisfaction [19–22]. However, previous studies have mainly used WeChat as a supplement to traditional in-person clinical teaching (hybrid mode) rather than have completely replaced face-to-face clinical teaching. As a result, it is difficult to know whether students' learning quality and learning satisfaction in the hybrid mode are attributable to the face-to-face part of teaching or WeChat part of teaching.

Under the compulsory policy of the lockdowns and social distancing requirements during the COVID-19, WeChat has completely replaced face-to-face clinical teaching in some Chinese medical schools. The present study aimed to compare pure face-to-face clinical teaching and WeChat teaching on Chinese digestive surgery interns' learning quality, English reading proficiency, and learning satisfaction. The present study did not aim to deny the benefits of face-to-face clinical teaching for students to practice hands-on and operational skills under the supervision of their teachers. Rather, the present study sought to understand that in emergent situations, such as COVID-19 pandemic, to what extent medical students' learning quality and satisfaction might differ between face-to-face teaching and WeChat teaching.

Specifically, the present study sought to answer the following four research questions:

(1) To what extent do learning quality differ between WeChat group and face-to-face group by interns' self-assessment?
(2) To what extent do learning quality differ between WeChat group and face-to-face group by peer-assessment?
(3) To what extent do English reading proficiency differ between interns who received WeChat group and face-to-face group?
(4) To what extent do learning satisfaction differ between interns in WeChat group and face-to-face group?

2. Methodology and procedure

2.1. Data and participants

The study adopted an experimental quantitative design, which randomly and equally assigned the participants into two groups: one group received traditional clinical teaching and the other group received teaching delivered by WeChat. The experiment lasted relatively short – only one semester.

Participants were recruited from the 62 final year clinical medicine students, who were digestive surgery interns in the digestive surgery department of a key comprehensive medical university affiliated with the Chinese Peoples' Liberation Army Air Force. Initially, all 62 interns agreed to participate in the study. The 62 participants were equally and randomly assigned to either the face-to-face group or the teaching delivered by WeChat. However, two withdrew from the study, which resulted in 60 participants, with 30 in face-to-face group and 30 in WeChat group. The participants aged between 21 and 24 years old, with an average of 22.5 years old. Among them 55 were males and only five were females. The uneven gender distribution was largely attributable to the fact that digestive surgery generally attracts male students in China.

2.2. The procedure of data collection

At the beginning of the course, the two groups were tested for their English reading proficiency (pre-English reading proficiency test). In traditional clinical teaching, interns attended face-to-face lectures. Then the teacher played European and American medical skill videos in the classroom and assigned questions for group discussions or hands-on practice, such as physical examination, operation, and surgical dressing change process. The interns had group discussions or practiced the required procedures in groups, the teachers then provided feedback to each group. At the end of each class, the teacher handed out supplementary learning materials, including the relevant Web of Science Indexed journal articles (e.g., Nature, Science, and Cell), the latest professional knowledge in English for gastrointestinal surgery, and medical news in English for interns to go through themselves.

WeChat group received the same content but via WeChat. Instead of face-to-face lectures, the prerecorded lectures, European and American medical skill videos, group discussion questions, or hands-on practice requirements were posted via WeChat. Interns completed the group discussions or hands-on practice using the group chat and video conferencing and recording functions in WeChat. There was no requirement as to when Interns should organize their group discussions as long as they completed the discussion tasks. This meant that the group members could negotiate a commonly agreed time period for group discussion. The teacher provided feedback remotely using the group chat and video conferencing functions. Instead of handing out printed supplementary learning materials, the teacher posted the PDFs or Word Documents in WeChat, so that Interns could view these materials flexibly and repeatedly.

At the end of the course, the interns in both groups were tested for English reading proficiency (post-English reading proficiency test), and completed the learning quality questionnaire twice (once for self-assessment and once for peer-assessment) and learning satisfaction questionnaire. The procedure of the data collection is summarized in Table 3.

2.3. The likert-scale questionnaire on learning quality

The learning quality was evaluated by a 4-point Likert scale (0-poor; 1-ordinary; 2-good; 3-excellent) questionnaire. The questionnaire consisted of five items on: 1) theoretical knowledge; 2) mechanism of gastrointestinal surgery; 3) operational ability; 4) current knowledge; and 5) case analysis skills. Interns were asked to evaluate their own learning quality (self-assessment) and their peers' (in the same group) learning quality (peer-assessment). Using peer-assessment was necessary as self-assessment alone would only represent interns' subjective reflections about their own learning. Moreover, using peer-assessment was also valid, as the course involved a significant proportion of group work, which also provided opportunities for interns to observe their peers' learning quality and provided peer-assessment.

2.4. The likert-scale questionnaire on interns' learning satisfaction

A 5-point Likert scale (1-strongly disagree; 2-disagree; 3-neutral; 4-agree; 5-strongly agree) questionnaire was used to evaluate interns' learning satisfaction in the two groups. The questionnaire was developed by Lee et al. [23] and was revised to suit the current research context. It had five items: 1) The learning increased my interest in the subject; 2) I felt I achieved the learning objectives; 3) I like the learning format (traditional/WeChat); 4) The learning helped improve my medical practical ability, and 5) The learning helped improve my English reading proficiency.

2.5. The English reading proficiency test

Both the pre- and post-English reading proficiency tests were taken from the reading section in Public English Test System (PETS) level 5 held in March 2019 and September 2019 respectively. PETS is developed by the National Education Examinations Authority in Mainland China. The tests consisted of five English passages, each of which was followed by 4 multiple-choice questions: one on lexical meaning, one on inferencing, two on details, and one on the main idea. The score of each question was 1.5 and the total test score was 30 for each test. Table 1 provides examples for each question type. Each test lasted about 50 min.

To examine if the interns in the two groups had the same English reading proficiency before the experiment, four two-sample t-tests were conducted using scores on lexical meaning, inferencing, details, and main ideas in the pre-English reading proficiency test as dependent variables respectively and using the group as the between-subject independent variable. The results are presented in Table 2, which show that the two groups did not differ in all four English reading skills: lexical meaning: $t (1, 58) = 0.15$, $p = .88$; inferencing: $t (1, 58) = 0.16$, $p = .52$, details: $t (1, 58) = 0.67$, $p = .51$, and main ideas: $t (1, 58) = 0.92$, $p < .36$.

Table 1
Example questions for the English reading proficiency tests.

Question type	Example question
Lexical meaning	The phrase "vocal … exponent" (line 2, para. 4) most probably refers to__ [A] eloquent doctor.
	[B] articulate opponent.
	[C] loud speaker.
	[D] strong advocate.
Inferencing	From Dr. Dustan's study we can infer that__ [A] a low-salt diet may be prescribed for some people.
	[B] the amount of salt intake has nothing to do with one's blood pressure.
	[C] the reduction of salt intake can cure a hypertensive patient.
	[D] an extremely low-salt diet makes no difference to anyone.
Details	According to some doctors and politicians, the amount of salt consumed__ [A] exhibits as an aggravating factor to people in poor health.
	[B] cures diseases such as stroke and circulatory disorders.
	[C] correlates highly with some diseases.
	[D] is irrelevant to people suffering from heart disease.
Main ideas	What is the main message of this text?__ [A] That the salt scare is not justified.
	[B] That the cause of hypertension is now understood.
	[C] That the moderate use of salt is recommended.
	[D] That salt consumption is to be promoted.

Table 2
Two-sample t-tests between face-to-face group and WeChat group in the pre-English reading proficiency test.

	face-to-face group		WeChat group		t	p	95% confidence interval
	M	SD	M	SD			
Lexical meaning	3.43	0.77	3.47	0.90	0.15	.88	−0.40, 0.47
Inferencing	4.27	0.87	4.23	0.77	0.16	.52	−0.46, 0.40
Details	10.33	1.16	10.53	1.17	0.67	.51	−0.40, 0.80
Main ideas	1.93	0.74	2.1	0.66	0.92	.36	−0.20, 0.53

2.6. Data analysis

To answer the first research question – if WeChat group and face-to-face group differed on their learning quality by self-assessment, we conducted two-sample t-tests using students' grouping as the between-subjects independent variable, and using the scores of students' self-assessment on each item in the learning quality questionnaire as the dependent variables. To answer the second research question – if WeChat group and face-to-face group differed on their learning quality by peer-assessment, we conducted two-sample t-tests using students' grouping as the between-subjects independent variable, and using the scores of students' peer-assessment on each item in the learning quality questionnaire as the dependent variables.

To answer the third research question – if WeChat group and face-to-face group differed on their post-English reading proficiency, we conducted a two-sample t-test using students' grouping as the between-subjects independent variable, and using the score of students' post-English reading test as the dependent variable. For the last research question – if WeChat group and face-to-face group differed on their learning satisfaction, we conducted two-sample t-tests using students' grouping as the between-subjects independent variable, and using the scores of students' responses to each item in the learning quality questionnaire as the dependent variables. All the t-tests were conducted in SPSS 15.0 software.

3. Results

The results of the learning quality by self-assessment and peer-assessment are presented in Tables 4 and 5 respectively. Self-assessment of learning quality shows that interns in WeChat group self-rated them having higher learning quality than face-to-face

Table 3
The data collection procedure.

	Face-to-face group	WeChat Group
At beginning of the course	Pre-English reading proficiency test	Pre-English reading proficiency test
During the course	Listen to face-to-face lectures in class;	Listen to prerecorded lectures in their own time;
	Watch European and American medical skill videos in class;	Watch European and American medical skill videos in their own time;
		Group discussion via WeChat group chat function;
	Group discussion in class; Hands-on practice in class;	Hands-on practice via WeChat video conferencing and recording functions;
	Read supplementary material in their own time	Read supplementary material in their own time
At the end of the course	Post-English reading proficiency test;	Post-English reading proficiency test;
	Learning quality questionnaire;	Learning quality questionnaire;
	Learning satisfaction questionnaire.	Learning satisfaction questionnaire.

Table 4
Learning quality questionnaire (by self-assessment).

	face-to-face group		WeChat group		t	p	95% confidence intervals
Theoretical knowledge	2.17	0.64	2.37	0.72	1.32	.26	−0.55, 0.15
Understanding mechanisms	1.9	0.48	2.20	0.61	2.11	**.04**	−0.58, −0.02
Operational ability	2.43	0.57	2.60	0.62	0.28	.28	−0.47, 0.14
Current knowledge	2.03	0.41	2.40	0.62	2.69	**.01**	−0.64, −0.09
Case analysis	1.87	0.35	2.17	0.53	2.60	**.01**	−0.53, −0.07

Table 5
Learning quality questionnaire (by peer-assessment).

	face-to-face group		WeChat group		t	p	95% confidence intervals
	M	SD	M	SD			
Theoretical knowledge	1.93	0.37	2.07	0.45	1.26	.21	−0.35, 0.08
Understanding mechanisms	1.77	0.43	1.97	0.32	2.04	**.04**	−0.40, −0.00
Operational ability	1.87	0.35	2.03	0.32	0.94	.06	−0.34, 0.01
Current knowledge	1.9	0.30	2.10	0.40	0.04	**.03**	−0.38, −0.02
Case analysis	1.80	0.41	1.87	0.43	0.61	.15	−0.28, 0.15

Table 6
Two-sample t-tests between face-to-face group and the WeChat in the post-English reading proficiency test.

	face-to-face group		WeChat group		t	p	95% confidence intervals
	M	SD	M	SD			
Lexical meaning	3.53	0.78	3.70	0.60	0.93	.35	−0.19, 0.52
Inferencing	3.13	0.68	3.80	0.76	3.57	**.00**	0.29, 1.04
Details	10.67	0.88	11.37	0.89	3.06	**.00**	0.24, 1.16
Main ideas	2.00	0.64	2.53	0.73	3.00	**.00**	0.18, 0.89

Table 7
Learning satisfaction of interns between face-to-face group and WeChat group.

	face-to-face group		WeChat group		t	p	95% confidence intervals
learning interests	3.23	0.57	3.63	0.61	2.62	.01	0.09, 0.70
learning objectives	2.97	0.61	3.37	0.72	2.32	.02	0.05, 0.75
learning format	3.03	0.32	3.43	0.63	3.12	.00	0.14, 0.66
medical practical ability	2.87	0.51	3.27	0.94	2.04	.05	0.01, 0.79
English reading proficiency	2.67	0.61	3.17	0.83	2.66	.01	0.15, 0.91

group in terms of understanding the mechanisms ($t(1, 58) = 2.11$, $p < .05$), current knowledge ($t(1, 58) = 2.69$, $p < .01$, and case analysis ability ($t(1, 58) = 2.60$, $p < .01$). Peer-assessment results demonstrate that interns in WeChat group were rated having better learning than the students in face-to-face group by their peers in terms of understanding the mechanisms ($t(1, 58) = 2.04$, $p < .05$) and current knowledge ($t(1, 58) = 0.04$, $p < .05$.

The results of the two-sample t-tests between face-to-face group and WeChat group in the post-English reading proficiency test are presented in Table 6, which shows that there were significant differences between the two groups in terms of inferencing $t(1, 58) = 3.57$, $p < .01$), details $t(1, 58) = 3.06$, $p < .01$), and main ideas $t(1, 58) = 3.00$, $p < .01$).

Table 7 presents the results of interns' learning satisfaction between the two groups. Significant differences were found on learning interests $t(1, 58) = 2.62$, $p < .05$, learning objectives $t(1, 58) = 2.32$, $p < .05$, learning format $t(1, 58) = 3.12$, $p < .01$, and English reading proficiency $t(1, 58) = 2.66$, $p < .05$. Students in WeChat group consistently had higher means than students in face-to-face group.

4. Discussion

4.1. Learning quality between WeChat group and face-to-face group

Our study compared the effects of learning quality between WeChat group and the face-to-face group. The results showed that interns in WeChat group had significantly higher means on understanding mechanisms and current knowledge by both self-assessment and peer assessment, and better case analysis skills by self-assessment only than those in face-to-face group. These results were similar to the studies which used other mobile applications in medical education, such as WhatsApp. Coleman and O'Connor [18] conducted a scoping review, which reported that the positive effects of using WhatsApp on medical students' knowledge gain in seven studies with 647 participants.

One of the possible reasons for the better effect of WeChat teaching on learning quality in these aspects could be that learning delivered by WeChat was more flexible, which allowed interns to watch prerecorded lectures and European and American medical skills videos at any time and location. Wang et al. [20], for example, also reported that the advantages of the flexibility features of using WeChat in Chinese medical education, which allowed students to access the course information anytime anywhere.

The prerecorded lectures might give interns opportunities to re-play multiple times whenever interns thought it was necessary. In that way, interns might increase their understanding of difficult points. On the other hand, interns in face-to-face group did not have such opportunities. Interns might easily miss an important point in class when their attention was diverted or when they were still in the process of understanding a previous difficult point.

Second, WeChat also allowed interns to organize their group work at their preferred time to suit everyone's timetable. This might also make group work more effective. The benefits of using instant messaging mobile applications to facilitate group work have also been reported by other researchers. For instance, Iqbal et al. [24] found that Saudi medical students commented that using Telegram assisted them with collaborative work. However, this speculation needs further verification as we did not measure how students in the WeChat group organized their group work. Similarly, when the teacher provided feedback in WeChat group, the recorded feedback could be played multiple times so that interns could clearly remember what they did well and what needed to be improved. This might have facilitated the communication between students and the teacher. In an experiment conducted with Chinese anesthesiology residents, Huang et al. [16] also reported that the benefits of WeChat in terms of convenient communication. In contrast, interns in face-to-face group could only remember the teacher's comments by heart in class time. If they missed some of teacher's comments or forgot part of the comments, they might not be able to improve their clinical skills by integrating these comments.

Despite many benefits of learning delivered by WeChat, it was not deniable that one of the advantages of traditional clinical teaching was that the hands-on practice and operational skills were better practiced in the face-to-face context. That might explain why there was no significant difference in operational skills between traditional and WeChat groups by both self-assessment and peer-assessment.

4.2. English reading proficiency between WeChat teaching and face-to-face group

In terms of interns' English reading proficiency, except for reading for details, the interns in WeChat group outperformed those in face-to-face group on inferencing, details, and main ideas. The better English reading proficiency could be attributed to that the supplementary materials post-ed in WeChat were able to be accessed by interns repeatedly. This might mean that interns in WeChat group were more likely to complete reading those supplementary materials than interns in face-to-face group, who received the printed supplementary materials. Our results were similar to previous research results that technology-enhanced learning environments (e.g., mobile learning), are effective in developing foreign language skills, including developing reading comprehension skills [9,25,26].

4.3. Learning satisfaction between WeChat group and face-to-face group

Our results indicated that interns in WeChat group had significantly higher means than those in the face-to-face group on the four out of five items in the learning satisfaction questionnaire, except for medical practical ability. These results seemed to be consistent with interns' own evaluation about their learning quality that no significant difference was found on operational skills between the two groups. As has been explained that teaching delivered by WeChat might not be as good as traditional clinical teaching in terms of developing interns' hands-on practical skills, such as physical examination, operation, and surgical dressing change process, as an in-person context might allow teachers to identify problems in these practices more easily. Teachers might also demonstrate these skills in face-to-face contexts so that interns could observe the demonstrations and improve on their own practice. This finding corroborated studies in other countries that medical students were concerned about the quality of clinical trainings through online delivery during the COVID-19 pandemic [27,28]. In general, however, our results showed learning satisfaction rated by WeChat group was higher than the face-to-face group, which aligned with previous studies of medical education in China [16,20].

5. Conclusions

During the COVID-19 pandemic due to frequent lockdowns and social distancing policy, WeChat has been employed in teaching in many disciplines in the higher education sector across China, such as science [29], tourism [30], and social sciences [31]. In general, our study showed the positive effects of using WeChat – a free mobile application – on Chinese medical interns' English reading proficiency, learning quality, and learning satisfaction, in gastrointestinal surgery training courses during the COVID-19 pandemic, which similar to findings of applying WeChat in medical education in China [16,20]. However, as reported in previous research that hands-on practice and operational skills were better practiced in the face-to-face context [28], students in WeChat group in our study also did not find WeChat was better in terms of developing their operational skills than traditional face-to-face clinical teaching and learning. Thus, WeChat may be considered as being one of the good options for distance teaching in emergent situations, such as in COVID-19, rather than replacing traditional face-to-face clinical teaching and learning in long-run.

Ethics approval and consent to participate

The present study was approved by the Ethics Committee of The First Affiliated Hospital of Air Force Medical University. Informed consent was obtained from all participants.

Declarations

Author contribution statement

Wei Zhou: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper. Zehua Wang: Performed the experiments; Wrote the paper. Feifei Han: Analyzed and interpreted the data; Wrote the paper. Liu Hong: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data.

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Declaration of competing interest

The authors declare no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e13434.

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