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# Distance learning and face-to-face learning in a pathophysiology problem-based learning course during a pandemic

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**Introduction:** During the past 2 years of the COVID-19 pandemic, education methods adjusted from conventional in-person classes to distance learning. Most classes were lectures that could go well if the participants were familiar with the online operation and had a stable network connection. However, problem-based learning (PBL) classes, which rely on the ability to engage in discussions, still had communication and group development limitations.

**Methods:** Here, we surveyed the learning effects of face-to-face (FF) and distance learning (DL) in a medical PBL course for two classes. Tutors and students were requested to give grades for five key areas (participation, communication, preparation, critical thinking, and group skills).

**Results and discussions:** A questionnaire found reduced participation, communication, and group skills in DL classes in comparison to FF classes. The tutors' perspective regarded participation and communication ability as reduced in DL. Nevertheless, one of the two classes showed no difference in group skills.

**Conclusion:** Our research shows the experience of a PBL class focusing on discussion and communication. In the post-pandemic era, whether FF or DL, classes should be appropriately adjusted to facilitate effective student communication.

## KEYWORDS

problem-based learning, PBL, distance learning, face-to-face, COVID-19

## Background and introduction

During the COVID-19 pandemic, education delivery shifted from conventional face-to-face (FF) methods to prevent the spread of COVID-19. Health policy advised that people avoid contact with others and adopt distance communication tools in workspaces, educational institutes, hospitals, and other places where large gatherings would pose a public health risk (Qian and Jiang, 2022). Because of the limitations to FF activity, education systems developed online distance learning (DL) tools to upload pre-recorded courses or conduct synchronous distance instruction.

David Sewart first defined "distance learning" as separating teacher and learner in space and time (Sewart, 1993). In 2002, Ulric Björck first reported information about asynchronous DL in a social economy problem-based learning (PBL) class (Björck, 2002). Most communication was conducted via texts delivered to students. In 2004, Brenda Ortiz at Columbia University also discussed DL in a PBL class, noting the importance of readiness, interaction, and group development. At that time, however, asynchronous technological tools were not affordable for

everyone, and the institute usually purchased them for the students. As technology has improved and its adoption become widespread, modern DL more often emphasizes synchronous learning. Synchronous learning means both voice and image can be delivered in real-time, so teachers and students have a similar experience to FF interaction, just over the internet.

Due to global commercial cooperation and the development of mobile internet (4G and 5G), several online distance education tools have been released. Internet communication technologies and services present a feasible solution for DL, especially when offered free of charge; this provides more choices and increases accessibility compared with expensive hardware systems that had previously been the only option (Kotevski and Milenkoski, 2018).

Most lecture-type classes work well online if the participants are familiar with the operation of the online platform and have a stable network connection. Some discussion-based classes have been adapted to the distance environment. This focuses on PBL, a student-centered approach, and learning via peer discussion. PBL was introduced and systematically developed by the Faculty of Health Sciences of McMaster University in Canada in the late 1960s. The University of New Mexico was the first to adopt a medical PBL curriculum in the United States.

PBL is widely promoted in medical courses globally. The learning style is a kind of guided self-learning, training medical students to find answers through group discussion or knowledge searching and filtering. A typical PBL class comprises four participant types: tutor, chair, transcriber, and group member (Wood, 2003). The tutor's primary function is to facilitate the proceedings, often taking on the role of a teacher. Their responsibility is to ensure that group discussions align with the learning objectives prescribed in the curriculum. Before the tutorial commences, a PBL tutor should thoroughly understand the material and establish ground rules, as the quality of student learning before and after the tutorial can impact individual and group dynamics within the tutorial setting (Chan, 2008). During the course, students are assigned the roles of chair and transcriber, which places leadership responsibility on the students themselves.

A global investigation indicated that medical education classes still used PBL during the COVID-19 pandemic (Chang et al., 2021). This demonstrates the importance of PBL courses in medical education; however, the effectiveness of converting the original FF courses into DL also needs to be evaluated. Our research surveyed the educational environment at National Cheng-Kung University (NCKU) during the COVID-19 pandemic. National Cheng-Kung University introduced PBL classes in the medicine department's course, "Introduction to Pathophysiology." Pathophysiology is the study of abnormal physiological symptoms that usually present in multiple syndromes. With the help of PBL, students can identify possible physiological information through group discussion.

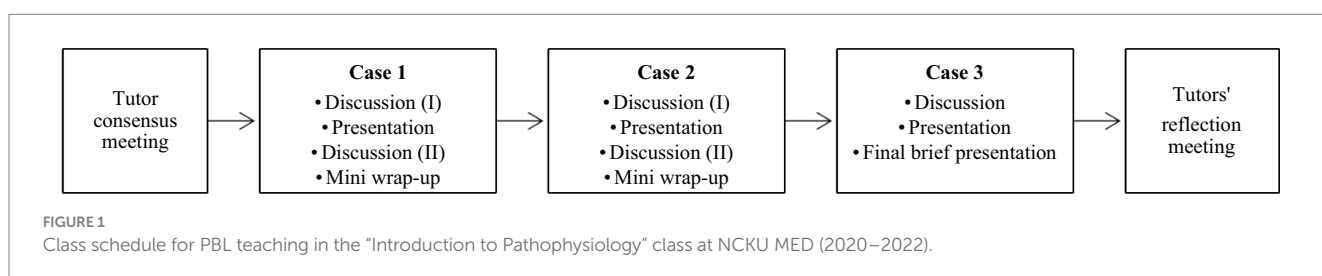
The PBL course design encourages student interaction and communication with each other and the teacher. In order to ensure that everyone has the opportunity to speak and discuss, the class is divided into small groups of fewer than eight people each to ensure that everyone has adequate opportunity to participate in discussions (Wood, 2003). The PBL class follows the block course and has corresponding cases with different pathophysiology systems. Each 18-class semester-long course covers three PBL cases, and each case schedule includes two discussions, a group presentation, and a group mini wrap-up. The semester starts and ends with a tutor meeting—a consensus conference at the beginning and a reflection meeting at the end (Figure 1). This is the only PBL class continually conducted in the Department of Medicine at NCKU.

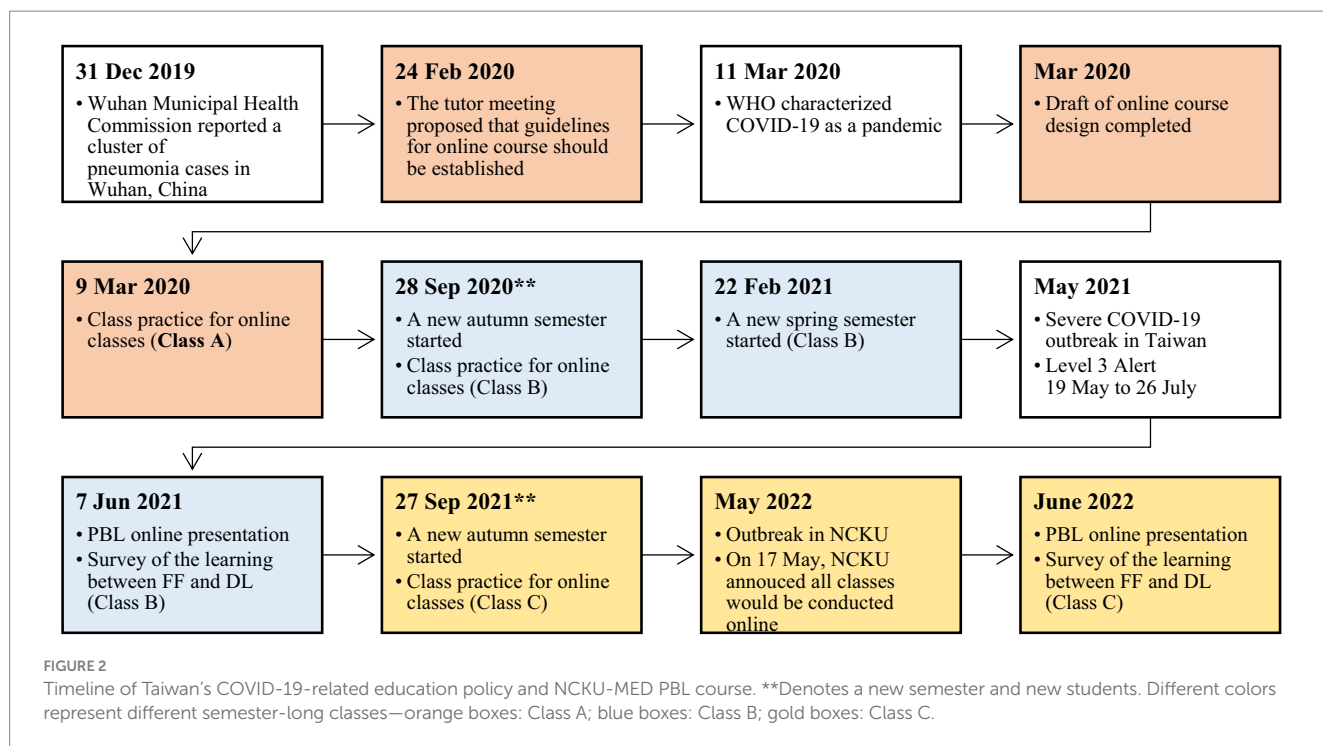
COVID-19 appeared toward the end of 2019, but the outbreak began in Taiwan in March 2021. Even before the WHO officially listed COVID-19 as an international infectious disease, the NCKU "Introduction to Pathophysiology" tutors proposed planning for distance teaching in the February 2020 tutors' meeting, as some tutors were physicians of infectious diseases or emergency medicine. From an epidemiological point of view and considering the medical conditions observed by the hospital, they proposed that DL plans be submitted as early as possible to avoid impacts on PBL learning from the pandemic. In May of the same year, we presented a draft DL guideline and asked Class A students to review the online teaching guide. In September 2020, the incoming Class B students began to use the distance teaching tools developed in the previous semester. Taiwan's government announced a "Level 3 Alert" in May 2021, and Class B students participated in the training through comprehensive online participation. The research team surveyed and collected questionnaires from Class B in June 2021. The global epidemic continued to peak in 2021. Class C began to practice distance teaching tools in September 2021. In May 2022, there was a COVID-19 outbreak on campus, and classes shifted entirely online. In June 2022, the second questionnaire was collected from Class C (Figure 2).

From the beginning to the exponential rise of the epidemic, government regulations and school rules affected the way students attended classes. The purpose of this study is to identify whether there are learning differences between FF learning and DL when medical students use these methods in PBL courses.

## Methods

This research was a retrospective cohort study of DL during the COVID-19 pandemic from 2020 to 2022 in the Department of Medicine, National Cheng-Kung University. Participants were fourth-year medical students enrolled in the "Introduction to Pathophysiology" PBL class. This research project was certified for





exemption from the Human Research Ethics Committee at National Cheng Kung University (NCKU HREC-Exempt-No. 111-511).

The research enrolled three discrete cohorts: Classes A, B, and C (Figure 2). Class A started their PBL class in February 2020 before the substantial impact of the COVID-19 pandemic on Taiwan. Class B began its PBL curriculum in September 2020, having accrued prior experience with various digital learning tools and thus demonstrating enhanced proficiency in digital pedagogy. Class C confronted the zenith of the COVID-19 pandemic and subsequently navigated the post-pandemic educational milieu, grappling with a distinctive set of challenges throughout their participation in the PBL course. The same tutors conducted the three consecutive classes, and online teaching experience accumulated through the course of the study. In summary, these cohorts experienced disparate iterations of PBL during a pandemic.

The NCKU PBL teaching group, in drafting the teaching guideline for a DL version of the course, considered many modifications. For example, unlike in conventional lecture classes, PBL courses include a meeting room and a whiteboard to record the discussion. These resources had to be replaced by online options. Most PBL essential equipment could be replaced by alternative approaches for DL (Table 1). However, the choice of online platform required consideration; was it better to choose a more accessible and complimentary platform such as Google Meet, or would a more reliable platform the university had already purchased, such as Microsoft Teams or Cisco WebEx, offer more functionality and security? During our online trials, for small PBL group discussions, participants recommended using the simple version of Google Meet to facilitate easy operation; if the number of participants was greater than 24 or 100, participants recommended using an online conference room with more comprehensive functionality to arrange the order of participant speeches.

TABLE 1 Comparison of traditional FF and DL methods.

Components	Traditional face-to-face	Distance learning
1. Location	Meeting room	Online platform
2. Discussion method	Directly talking	Microphone/webcam
3. Note recording	Whiteboard	Typing texts/iPad writing application/Google Draw*
4. Handouts	Papers	Electronic pdf file/Mobile application
5. Group presentation (<12 people)	Meeting room/projector	Online-meeting media with easy operation: Google Meet*
6. Mini wrap-up (<24 people)	Meeting room/projector	Online-meeting media with easy operation: Google Meet or Microsoft Teams*
7. Final presentation (>100 people)	Lecture hall/projector	Online-meeting media with hosting options: Microsoft Teams or Cisco WebEx*

\*Most groups preferred using.

Feedback plays a crucial role in monitoring students' learning experiences. In this research, we designed a questionnaire based on the Nendaz and Tekian Assessment framework (Nendaz and Tekian 1999) to assess the impact of online teaching on learning outcomes during the COVID-19 pandemic on tutors and students. The research of Nendaz and Tekian emphasized that assessment should include working through problems to assess knowledge and problem-solving

skills. The questionnaire format was adapted from research conducted in medical education at Hong Kong University (Foo et al., 2021). In this survey, tutors and students were asked to grade five key areas against previous experience (Chen and Chin, 2014): participation, communication, preparation, critical thinking, and group skills.

Here, participation was used to gauge students' interest and enthusiasm in the class, spontaneity in engaging in discussions, and willingness to provide feedback. Communication, on the other hand, was used to evaluate how students conveyed their thoughts. Lower scores suggested less effective expression with fragment words, while higher scores indicated clear and precise articulation of ideas. Preparation was used to assess students' ability to grasp the learning issue, draw from diverse sources, and demonstrate the capacity to synthesize a range of perspectives. Critical thinking assessed students' ability to question and challenge differing viewpoints, fostering a deeper understanding of the subject matter. Using group skills could evaluate students' capacity to collaborate with their peers to complete class activities, and improved group skills suggested an ability to encourage active participation from others (Supplementary information).

After each class, tutors and students were asked to anonymously complete an online survey. After collection, we collated data on these five factors, including mean scores, standard deviations (SD), and the number of respondents (n). We then conducted a t-test for statistical comparison. For the statistical analysis, GraphPad Prism was employed with the finalized data. This software enabled more in-depth statistical assessments to elucidate the differences in learning outcomes between the two teaching methods.

## Results

This research collected data from two classes (Class B and Class C). In Class B, we collected information from 13 tutors and 84 students to conduct the grading survey; for Class C, 15 tutors and 76 students participated in the survey. The final data (Supplementary Tables S1–S4) were analyzed using GraphPad Prism, and the data (mean, SD, n) were imported to t-tests for comparison.

Class B students were about 22 to 23 years old ( $22.5 \pm 1.3$ ), and the class gender composition was 53 men (53/84, 63.1%) and 31 women (31/84, 36.9%). For Class B, data have similar statistical results

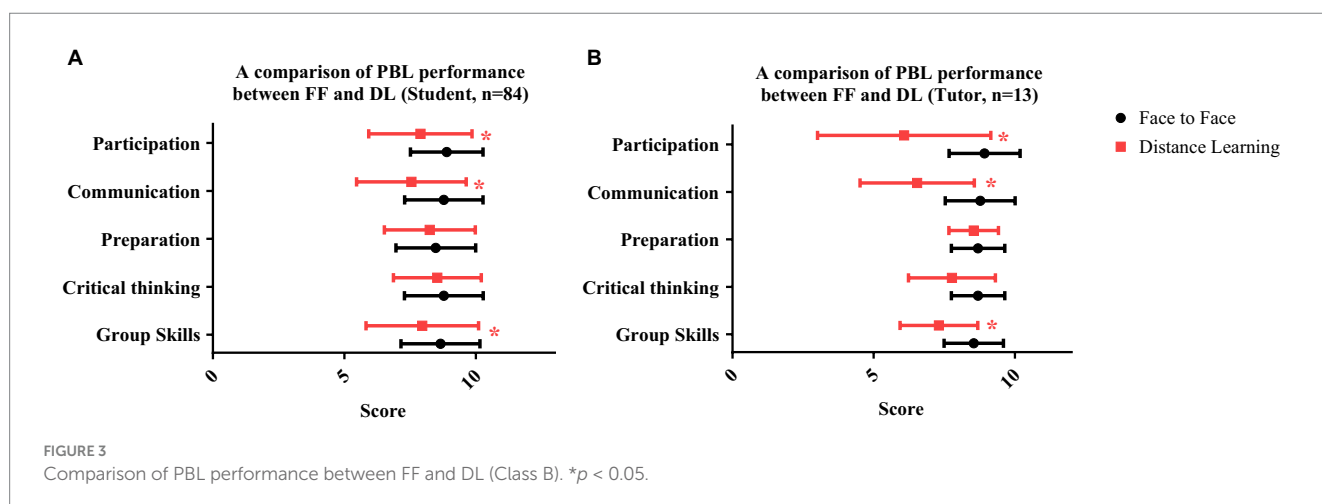
between tutors (Figure 3A) and students (Figure 3B), and three points have significant differences between FF and DL (including participation, communication, and group skills). Among them, from the perspective of tutors, we can see that the average gap is quite large in terms of participation and communication. During FF teaching, when the discussion is out of focus or students are confused, tutors can give prompts from the side; during online teaching, tutors can only know the students' learning status (participation and communication) from the talking and note recording. In Class B, whether students or tutors, the five scores for FF are higher than DL, but the impact of participation, communication, and group skills is more significant.

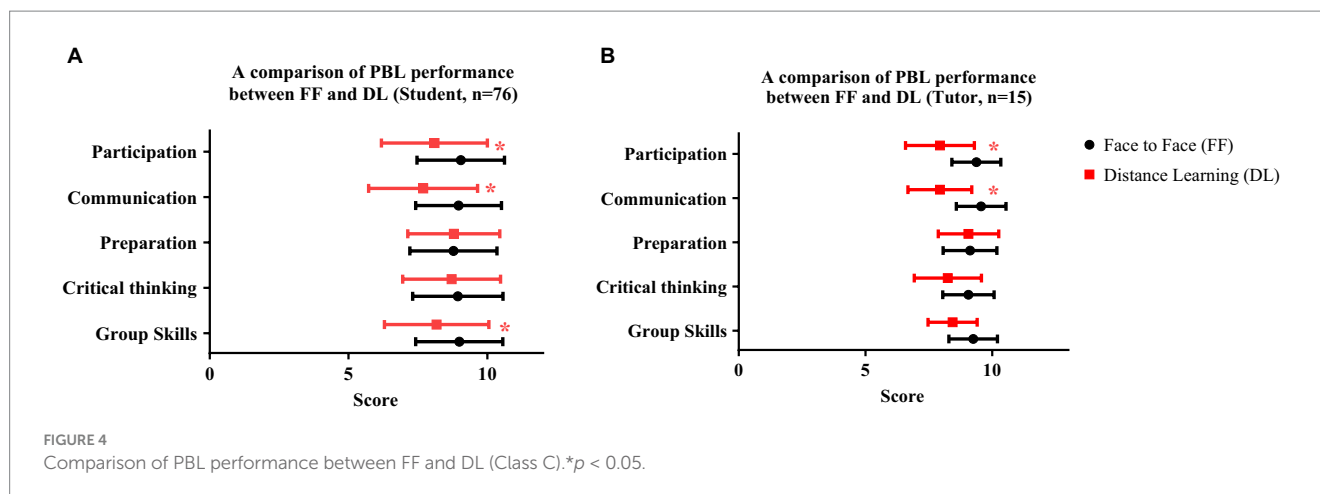
The Class C students (Figure 4) were about 22 to 23 years old ( $22.6 \pm 1.6$ ), and the class gender composition was 50 men (50/76, 65.8%) and 26 women (26/76, 34.2%). For Class C, two points significantly differ between FF and DL (including participation and communication) in both students (Figure 4A) and tutors (Figure 4B). The ratings of Class C students show overall rating trends similar to those of Class B. Participation, communication, and group skills significantly impact learning outcomes. The tutor data of Class C show significant differences in participation and communication between FF and DL. However, after the tutors had experienced more online teaching, results showed that compared with Class B, Class C has a significantly smaller error bar in these two items.

## Discussions

### How can participation, communication, and group skills for PBL learning be improved?

Three parameters in both Class B and Class C students (participation, communication, and group skills) showed lower scores due to participants' unfamiliarity with online tools. Another identified issue was the delay and asynchronous communication due to the limitations of the internet. Online meeting platforms automatically shut down video streaming to prevent freezing and maintain good audio connectivity. In addition, even if the camera works, members sometimes wear masks or fail to look at the camera; thus, online meetings lack eye contact and facial expressions. Eye contact is critical





during class in both traditional lectures and online teaching (Poláková and Klímová, 2021). Participants use their eyes to supplement verbal communication; improving this aspect of the online experience is expected to improve participation and communication.

PBL classes are led by students rather than by tutors. A key role is that of the chairperson, who leads the PBL discussion. The chairperson should ensure that the conversation includes all members. In this step, if there are interruptions due to internet connectivity, it will disrupt the flow of the discussion. Another role in the PBL group is the transcriber, who writes down key discussion points and ideas on the whiteboard in the FF class. In the online course, transcribers must use online media or write using an electronic whiteboard (such as an iPad) (Supplementary Figure S1). As shown in Table 1, the chair and the transcriber should be familiar with the operation of the online platform and monitor the stability of the internet to ensure efficient and fluent discussion. In our research survey, Class C tutors who had experienced more online classes and were more familiar with online tools showed no difference in group skills. These results suggest that group-based learning courses can work well even in a DL format.

## Distance learning (E-learning) in the post-pandemic era

Due to the challenges of COVID-19, educational institutes worldwide have started to emphasize the importance of online classes and modernizing the educational environment. From 2020 to 2021, the spread of the global pandemic caught schools unprepared and necessitated rapid implementation of new methods. For example, in the past, growing demand for internet connectivity led to schools increasing Wi-Fi coverage, but in the COVID-19 period, more stable internet connectivity was more important than range.

Our study included a text survey to collect students' opinions; interestingly, some students gave positive feedback on DL. For example, some students prefer the electronic writing board over the traditional whiteboard. Reasons included that the electronic writing board could be viewed on every member's laptop or mobile phone. Text and figures could easily be imported and their display location rearranged.

New learning methods will likely transform FF and online DL classes in the post-pandemic era. These findings highlight the importance of building familiarity and proficiency with online tools before using them for PBL discussion. The educational landscape of the last few years demonstrates the importance of methodological flexibility and the potential benefits of adopting new technology and methodologies. We recommend two approaches for online teaching: first, during outbreaks of infectious disease or similar crises, classes could move entirely online to avoid FF interaction. Second, if only a few members are affected by COVID-19 or other illnesses, in-person classes could still be conducted but include a synchronous online discussion.

## Conclusion

In this study, a questionnaire found reduced participation, communication, and group skills in DL classes in comparison to FF classes. Our research provides insight for classes such as PBL classes that focus on discussion and member brainstorming. The PBL methodology is crucial for medical students to develop communication and critical thinking skills. In the post-pandemic era, whether FF or DL, classes should be appropriately adjusted to facilitate effective student communication.

## Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

## Ethics statement

The studies involving humans were approved by the Human Research Ethics Committee at National Cheng Kung University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

F-HC: Data curation, Formal analysis, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. P-JW: Investigation, Methodology, Writing – review & editing. C-HC: Conceptualization, Methodology, Supervision, Writing – review & editing. All authors contributed to the article and approved the submitted version.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/feduc.2023.1289526/full#supplementary-material>