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Online higher education during and beyond COVID-19 pandemic: Insights from professors and students at a Taiwanese university

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ABSTRACT

Due to the COVID-19 pandemic, higher education institutions worldwide were compelled to close their campuses and relocate their educational operations to online platforms. This study investigates the aspects that contribute to the efficacy of online education and examines the perceptions of professors and students at a Taiwanese university about the benefits, limits, and suggestions of online learning in COVID-19. A three-stage research framework comprising literature review, interviews and thematic analysis was applied to obtain a thorough understanding of the phenomenon. Remote learning, convenience, and easy accessibility were among the benefits, whereas inefficiency and difficulties in preserving academic integrity were among the drawbacks. Students suggested that blended lectures, dividing lectures into chapters, weekly assignments, regular online meetings and open-book exams might enhance learning outcomes in online courses. According to the suggestions, professors should be trained on using online technologies and building courses with more interactivity. Despite the importance of digital technologies in online learning, professors need to consider minimizing technological needs based on students' situations. Key lessons learnt from this study are discussed in the hopes of providing beneficial recommendations for educational policymakers, educators, students, and researchers to promote effective education in both online and classroom modes during and after the COVID-19 pandemic.

Keywords: digital technology, online learning, higher education, students' perspectives, teachers' perspectives

INTRODUCTION

The coronavirus pandemic has sparked significant change, posing several difficulties to higher education throughout the world. Several higher education institutions worldwide have postponed or cancelled their academic events along with physical classes to curb the spread of the virus. These interventions have had far-reaching social, economic and psychological repercussions for undergraduate and postgraduate students (Son et al., 2020; UNESCO, 2021). As a result of this COVID-19 pandemic, educational institutions such as universities are being forced to transition numerous courses and programs from a physical to an online delivery manner without adequate planning and prior preparation. Transformational shifts toward digital education were evident before the pandemic but quickened during the pandemic. While online learning is not new to learners, it is new to university professors and students. Online education will be adapted and transform higher education beyond this pandemic due to the rapid advancement of technology and social propensity for it. Undoubtedly, teachers and students are critical pillars of the education system. Thus, in this study, we tried to understand the opinions on online education, challenges encountered during online classes due to COVID-19, and any recommendations for improving online education from the professors and students from diverse academic departments of National Taipei University of Technology (Taipei Tech).

The COVID-19 pandemic is one of the most significant crises in current times. The first reported case of COVID-19 dates back to 17th November 2019 in China (Bryner, 2020), and the first confirmed case to have spread to Taiwan on 21st January 2020 (Taiwan Centers for Disease Control, 2020). The present COVID-19 epidemic began in early 2020. COVID-19 was first reported as a public health emergency of worldwide concern by World Health Organization on 30th January 2020 before being elevated to a pandemic on 11th March 2020 (Sharma & Sha, 2020). Interventions such as social distancing were used to prevent the spread of the disease (Venkatesh & Edirappuli, 2020). This measure led to less person-to-person contact and greater dependence on digital technologies. Many higher education institutions worldwide have been forced to

transit towards online teaching due to the COVID-19 epidemic; challenging for higher education institutions to develop online education strategies without prior preparation. Compared to many other nations, Taiwan handled the COVID-19 pandemic efficiently in the early stages. Several Taiwanese universities had begun offering online education at the time of the COVID-19 outbreak. Despite having the potential infrastructure, the implementation of online education was lagging behind. In Taiwan, due to the physical shutdown of universities, the transition to online teaching and learning accelerated during the COVID-19 epidemic. Transitioning to online learning leads to the reliance upon existing digital technologies.

Without a doubt, using online learning for studying is a sensible approach as this pandemic continues to spread. However, transitioning to online classrooms comes with certain challenges for both students and educators (Dayagbil et al., 2021). Due to the enormous advancements in digital technologies over the last few decades, online learning is not new to learners (García-Morales et al., 2021). However, this sudden complete shift of the whole curriculum towards online learning methods is new to university faculty and students (Turnbull et al., 2021). Even though we are living in a time of digitalization, it is naive to presume that students have access to digital resources and naturally know how to use them for online learning. Similar concerns can be inferred about educators utilizing digital tools to provide online teaching. Most educators had to change teaching, evaluation strategies and mentoring approaches overnight as a result of the COVID-19 lockdown. Due to this unprecedented situation, the impact of COVID-19 on higher education is getting significant scholarly attention. Questions remain on whether online education is compelling, engaging and able to reach all learners equitably. During this crisis, issues have been raised about how governments and educational institutions can provide education and students can utilize it. The present study highlighted several questions in light of these circumstances.

1. What are the students' perceptions of online education, requirements, related challenges during COVID-19 and possible suggestions to improve online education?
2. What obstacles and solutions have professors noticed regarding online education during this pandemic?

According to our literature review, only a handful of studies have focused on the impacts of the COVID-19 crisis on university students and teachers in Taiwan regarding online education (Hu, 2021; Lin, 2021; Wu, 2021). Research must continue to focus on online teaching and learning activities among Taiwanese universities due to this pandemic's ongoing and persistent nature. In order to answer the above concerns, this study aims to investigate teachers' and students' perceptions of online education, learning and teaching approaches, necessities, suggestions and difficulties faced during the COVID-19 pandemic. Accordingly, we adopted a systematic approach that included a literature review, interviews and thematic analysis to learn from professors and students of Taipei Tech. The results suggest that location flexibility, convenience, easy referencing, and ease of access were among the benefits, whereas technological complications and concerns in preserving academic integrity were among the problems. With students expressing their needs, professors have provided opinions and strategies on utilizing online technologies for developing courses with more interactivity. The current study is timely as Ministry of Education (MOE), Taiwan, announced to spend NT$20 billion (US$719 million) on improving digital learning (Focus Taiwan, 2021). We hope the findings and research discussions mentioned in this study will facilitate practical and effective educational policy implications for the adoption and implementation of online learning.

RESEARCH BACKGROUND

Online learning is nothing new to learners, nor is distance learning. With the spread of the internet, the digitization of education is advancing rapidly, and research studies demonstrated its importance to education (Naresh & Reddy, 2015). Massive open online courses (MOOC) platforms such as Coursera, edX, and Udacity are growing, offering free or paid educational courses and programs (Littenberg-Tobias & Reich, 2020). The emergence of online learning has driven educational institutions to revamp their educational systems (Yang & Cornelius, 2004). The aspects of education are changing. Students can access quality education conveniently from digital gadgets using the internet at a low cost (Abdulmajeed et al., 2020). COVID-19 has compelled universities all around the globe to use online learning without enough training or preparation.

Online learning can be defined as remote learning aided by electronic devices such as tablets, smartphones, laptops, and desktops that require an internet connection. Scholars often categorize e-learning, online learning, and distance learning as similar modes of online education. However, various online learning labels have different expectations and perceptions (Moore et al., 2011). With time, online learning has grown in popularity as a cost-effective, convenient method of imparting knowledge to students and a viable alternative to traditional face-to-face education (Larreamendy-Joerns & Leinhardt, 2006). As the quantity of online education courses in higher education has grown, scholars have raised questions and issues concerning the quality of these courses.

Higher Education in Taiwan at the Time of COVID-19

During the initial phase of the COVID-19 pandemic, Taiwan responded reasonably well to the crisis compared to many other countries, where the number of confirmed cases and deaths reached thousands (Steinbrook, 2021). To prevent the spread of COVID-19, Taiwan enacted several rules and regulations that could have helped the country keep the number of infections and fatalities relatively low compared to the other parts of the globe (Farr & Gao, 2020; Summers et al., 2020). MOE declared on 3rd February 2020 that universities and colleges will be closed until 25th February 2020 (Cheng et al., 2020). On 20th February 2020, MOE established rules for class suspension. If a teacher or student obtained a confirmed diagnosis, their classes were suspended. Two confirmed diagnoses resulted in a campus-wide suspension for 14 days, with online make-up classes. On 27th February 2020, restrictions were elevated to a level one alert by the Taiwan Central Epidemic Command Center (CECC) (MHW, 2020). On

13th March 2020, MOE advised colleges and universities to carefully analyze the pandemic situation in each nation and the danger of infection through air travel and limit or suspend international travel by teachers and students (MOE, 2020). COVID-19 preventative restrictions were significantly eased after several months of no local cases. Taiwan's universities maintained in-person teaching as much as possible during this stage of the pandemic (Chiu, 2020). Taiwan faced a major outbreak in May 2021 (Hollingsworth, 2021). On 15th May 2021, Taiwan imposed new restrictions, including the closure of educational institutions (Soon, 2021; Taiwan Centers for Disease Control, 2021). By then, Taiwanese universities deployed remote teaching arrangements wherever possible to offer virtual learning opportunities for students. Due to pragmatic, strict measures and vaccination policies nationwide, on 17th July 2021, there were just eight new domestic cases (Wang & Ellis, 2021). Without domestic transmission for several months, Taiwan faced its biggest outbreak in April 2022. On 9th May, by adhering to government policies, Taiwanese universities implemented remote teaching arrangements till the end of the spring semester.

To tackle the COVID-19 epidemic without cancelling coursesMOE in Taiwan has established a nationwide virtual learning network that encompasses all academic sectors, including higher education (MOE, 2021). This platform also offers a collection of digital learning programs and materials available across all platforms for usage by all institutions. Taiwanese higher educational institutions have changed physical classrooms to virtual ones on digital learning management systems (LMS) and provide synchronous or asynchronous education through online classes in accordance with CECC's regulations on social distancing. Among the surge of research papers on teaching and learning during the time of COVID-19, the number of studies in the context of Taiwan is extremely low. Only a few studies have highlighted how COVID-19 has impacted students' online learning (Hu, 2022; Lin, 2021) and provided insights into how teachers conduct online teaching during COVID-19 (White, 2020; Wu, 2021). Given that the duration of the crisis is unknown, it is crucial to continue research on understanding the effectiveness of online teaching and learning modalities implemented during COVID-19.

Challenges and Limitations Regarding Online Education

Many scholars questioned whether online learning could provide the same level of interaction between teachers and students as traditional classrooms (Roblyer, 2000). In general, there are two primary modes of online learning. One kind is 'asynchronous' in which the teacher provides pre-recorded content, and students later watch them online. In this mode, there was no way for instructors and students to communicate over the internet, and it is similar to self-study materials being distributed. On the other hand, in 'synchronous' mode, teachers educate and converse with students in real-time (Hrastinski, 2008). Interestingly, synchronous teaching has been criticized over the years for having instructor-centric designs that prioritize teachers above pupils (Murphy et al., 2011). The biggest impediment to the effective implementation of online learning systems that most institutions have encountered is the lack of access or obsolete technology infrastructure (St. Amant, 2017). The lack of technological infrastructure impacts teachers' and students' online learning experience (Moore & Fodrey, 2018). Teachers play a critical role in online learning, yet in the many cases reported in the literature, students suffer from the teachers' lack of support and effort (Appana, 2008). The student's motivation is one of the critical elements that directly influence the success of an online learning system (Park & Choi, 2009). It has been shown that more motivated learners do better than those who are not (Hoskins & Van Hooff, 2005). Diverse socio-economic, socio-cultural, and technical infrastructure elements influence higher education, teachers' and students' online learning experiences differently in developing countries than in developed countries (Mashile & Pretorius, 2003). A study that recognizes technological issues as the primary factor for online education's success indicated that most online learning schemes provided by higher education institutions in developing countries are unsuccessful (Al-Araibi et al., 2019).

Beneficial Aspects of Online Education

Despite the limitations and challenges, considerable research in the field of online education shows several beneficial aspects of online education. Online learning overcomes the barriers of time and space by allowing students to learn virtually without physically attending educational institutions (Li & Irby, 2008). Instead of teaching the entire class in person, teachers can record their lectures or find videos made by others and share them with their students through the internet, which is effective in developing students' competencies. Scholars asserted that online education might assist higher education institutions in extending to provide their curriculum at a lower cost and help graduates obtain crucial skills to increase their marketability (Arkorful & Abaidoo, 2015). Online learning also allows easy referencing. While taking online classes, students may quickly and conveniently verify the information sources and the meaning of unknown phrases, terminology and complex concepts (Ally, 2004). If students miss attending a class physically, typically, it is not easy to get the lecture resources for that class. Furthermore, the teacher cannot repeat the lesson for each pupil who missed it. Online learning permits students to retrieve electronic learning resources whenever they need them (Gilbert, 2015). Interactive e-learning elements boost students' motivation for learning in higher education (Abou El-Seoud et al., 2014). Scholars suggest that online education may encourage non-discriminatory teaching and learning practices since teachers and students, as well as students and their peers, generally do not interact face-to-face (Tuomi, 2013). Students' collaborative learning and problem-solving abilities may be enhanced by online education (Saadé et al., 2012).

Online Education in the time of COVID-19

The pandemic compelled higher education institutes worldwide to adopt new technologies and abruptly modify their operational approaches. Prior to the pandemic, many countries may have the substantial technological infrastructure to implement online education, whilst others may not have the same level of technical infrastructure (Gao & Hayes, 2021). However, most universities around the world

were not prepared to shift their curriculum entirely towards online education (Budur et al., 2021; Carroll & Conboy, 2020). Due to the sudden impact of COVID-19, higher education institutes did not get enough time to consider how new technologies and accompanying educational strategies should be implemented and incorporated into their current curriculum structure. With the increased usage of online technologies during COVID-19, it is crucial to analyze their efficacy in learning and teaching from various perspectives.

Several studies from around the world have tried to assess the impact of the COVID-19 crisis on higher education from the perspective of students and teachers. An early research study on COVID-19 presented a timely map of the responses of higher education to this pandemic across 20 nations (Crawford et al., 2020). Research studies from India (Chakraborty et al., 2021), Nepal (Gautam & Gautam, 2021), Bangladesh (Sarkar et al., 2021), Norway (Almendingen et al., 2021), the United States (Aguilera-Hermida, 2020) and many other nations have reported on usage, acceptance, perceptions of students pursuing higher education, and various consequences due to the sudden shift from classroom-based to online learning. Although students feel that online education permitted them to continue their studies during the pandemic, they expressed that they learn better in face-to-face teaching than in online teaching. In online education, students lack physical interaction and help from their classmates. Moreover, they do not have the privilege to access the library and laboratories (Bojović et al., 2020).

Access to the internet and digital devices is a necessity for online education. Previous pre-pandemic studies have already reported inequalities among different economies accessing online education due to the lack of technology infrastructure (Abdulmajeed et al., 2020; Lembani et al., 2020). During the time of COVID-19, existed digital divide in higher education has become more worsened (Shackleton & Mann, 2021). In developing countries, students with limited access to the internet and digital devices, as well as those who are unfamiliar with them, have difficulties adapting to online education (Mathrani et al., 2021). Some students face problems attending online classes in their homes as the living spaces are not spacious enough. Institutions with insufficient resources and socially deprived students who have restricted access to technology and the internet adversely affect the capability of students to participate in online teaching-learning environments.

This sudden shift to online education without previous planning was challenging for higher education institutes. Universities are increasingly employing new techniques to ensure that their students receive continuous education during COVID-19 (Daniel, 2020). Undoubtedly, similar to the students, teachers face various challenges and complications in efficiently performing their duties and providing education. Some scholars doubt the quality of online education during the pandemic, as the educators who teach online courses do not get any proper training regarding teaching online (Sadeghi, 2019). Only a few research studies from around the world, such as in China (Bao, 2020), Australia (Scull et al., 2020), Hong Kong (Moorhouse & Kohnke, 2021), and Italy (Casacchia et al., 2021), have shown insights into teaching approaches, perceptions of adopting online teaching, and challenges during COVID-19 from teachers' perspectives in the context of higher education. Teachers are increasingly using a variety of online software to teach their classes. For online lectures and discussions, teachers are using video conferencing systems such as Google Meet, WebEx, Zoom, Skype, and Microsoft Teams, which facilitate features like digital whiteboards, slideshows, chat rooms, quizzes, discussion forums, and polls (Fatani, 2020; Nguyen & Nguyen, 2021). Teachers are using online educational platforms like Google Classroom (Hussein et al., 2022), Edmodo (Halil, 2020), Moodle (Ghounane, 2020), and Blackboard (Stack et al., 2020) to provide course information, notes, and other multimedia resources relevant to their courses with students. Some universities also make course materials available on their own LMS (Makumane, 2021; Raza et al., 2021). These online educational platforms, along with LMS, facilitate easier integration for students to submit their assignments, and teachers can keep track of their student's progress. In addition, instructors are using virtual laboratories to teach science courses, and students can use virtual laboratories to simulate experiments relevant to their studies online (Kapilan et al., 2020; Vergara et al., 2021).

Despite the challenges, online learning has more to provide in higher education during and beyond the pandemic. Two critical aspects of a successful educational system are teachers and students. Thus, understanding the impact of the transition toward online education during COVID-19 from the perspectives of university students and professors will provide a roadmap for online higher education course design. This pandemic presented an opportunity to learn about the opinions of professors and students from various higher educational domains on a broad scale.

METHODOLOGY

The current study investigates professors' and students' perceptions of online education approaches at Taipei Tech during the COVID-19 epidemic. Though the situation was complex during COVID-19, Taipei Tech took the initiative with several strategies for offering online education using the aid of the university's own LMS, Taipei Tech i-school plus. This system provides a virtual environment for distributing video lectures and other resources, meeting students, interacting with them, and grading them. Professors also use online software such as Microsoft Teams, Google Meet, or WebEx to conduct online classes; Google Classroom, Zuvio for tests, evaluation, attendance, and LINE for messages.

In order to understand and perceive the participants' perspectives, this study used a qualitative design that included a review of literature, interviews and thematic analysis. Qualitative research is considered to be effective for guiding a comprehensive study plan by using exploratory inquiries (Flick, 2018). Rather than identifying cause and effect, qualitative research gives an insight into a circumstance that tells the narrative (Merriam & Tisdell, 2015). Self-administered and open-ended questionnaires are used in qualitative research to obtain data (Marshall & Rossman, 2014). This study's research methodological framework is divided into three parts. The literature review on online education adoption factors and barriers was done in phase one.

Table 1. Interview questions for students

Themes	Interview questions
Learning differences	What is the difference in learning between physical and online courses?
	What are differences in class attendance/engagement/learning outcomes/assignments, reports, & exams between physical & online courses?
Learning difficulties	What are the difficulties/problems faced in online courses?
Overcoming strategies	How to overcome them?
Improvements	How can online classes be improved?
Suggestions	What suggestions would you like to provide regarding interaction (teacher-student, peer)/assessment/programming/ teaching methods/curriculum resources/others?
Feedback	Name a favorite online class and explain why you like it.

Table 2. Interview questions for professors

Themes	Interview questions
Overall attitude	Do you prefer to teach online?
	Would you like to teach online in the future?
	Under which circumstances are you willing to adopt online teaching?
Teaching objectives	Is the course lecture-based, hands-on, or discussion-based?
	Is the course suitable for online teaching?
	Did you achieve the stated teaching objectives?
Teaching difficulties	What are the challenges you encountered?
	How to overcome them?
	From a teacher's point of view, what are the difficulties you think students encounter in online courses?
	According to you, how to overcome them?
Additional support	Is there enough assistance?
	What are the remaining needs?
Teaching strategy	What teaching strategies were you using?
	Is there any difference from the physical teaching?
	Is there a difference in planning to teach?
	Are there any adjustments you make to the teaching strategy/content?
	How do you guide students through the curriculum?
	How to maintain students' focus?
Interaction	What is the impact on teacher-student interaction in the classroom?
	How to promote interaction?
	What is the impact on peer interaction in the classroom?
Test & evaluation	What are the assessment methods you are using?
	Are there any adjustments you have made for the online teaching mode?
	How do you think it can be accommodated?

Based on those characteristics, an interview guide was created in the second phase to investigate professors' and students' opinions of online learning modes, challenges, benefits, and recommendations. Thematic analysis was done in phase three to classify the findings from the interviews of professors and students.

Table 1 and **Table 2** present the interview questions for students and professors, respectively. We have established the interview questions for students based on themes such as learning differences, learning difficulties, overcoming strategies, improvements, suggestions, and feedback. On the other hand, the professors' interview questions comprised the following themes: overall attitude, teaching objectives, teaching difficulties, additional support, teaching strategy, interaction, test, and evaluation.

This qualitative case study was conducted from June to July 2022. We have carefully considered this timing to interview students during the semester break after semester grades are posted so they are free to express their opinions and problems. Participants for this study were six professors (called as T1-T6) from six different colleges of Taipei Tech (College of Mechanical & Electrical Engineering, College of Electrical Engineering & Computer Science, College of Humanities & Social Science, College of Engineering, College of Management, and College of Design) and sixteen students (called as S1-S16) from those colleges. That covers all colleges of Taipei Tech from diverse disciplines. The number of participants in this study was selected based on the recommendation of five to 25 respondents, which is deemed sufficient for a qualitative research study (Marshall & Rossman, 2014; Sandelowski, 2001). Participants participated in the interview conducted via Google Meet, with each interview lasting between 38 and 58 minutes. All interviews were audio and video recorded, afterwards transcribed verbatim, and re-watched to confirm the accuracy of quotes used to illustrate professors' and students' perceptions of online teaching and learning opportunities.

RESULTS

Our study outlines students' and professors' perspectives regarding approaches, limitations, and recommendations on online learning during COVID-19. Students are the crucial consumers of online higher education from the other side of the screen.

Table 3. Reasons to like physical classes over online classes

Reasons	Excerpts
Interactivity	"When I am in physical classroom, it is easier for me to interact with my classmates & teacher" [S9].
	"The feeling of participation while taking a physical class is greater" [S3].
Easy accessibility to ask professors	"In the classroom after the class, I can ask questions to the teacher in private" [S2].
Lack of attentiveness in online education	"I easily get distracted while taking an online class through my PC" [S14].
	"It is hard to pay attention while attending an online class, and it is like listening to a podcast" [S8].
More assignments during online classes	"Teachers assigned more assignment reports in online classes" [S9].
Need extra time & effort in online learning	"I need to spend a lot of extra time learning things online" [S10].
	"Online group discussions and discussions about classes in LINE take so much time" [S5].

Table 4. Reasons to like online classes over physical classes

Reasons	Excerpts
Easy referencing	"In online classes, video quality is great, and it is easy to follow and learn. I can take screenshots which is helpful in note-taking and review them later" [S12].
Attention	"Online classes are more focused and not bothered by classmates. I cannot ask classmates questions online easily, so I must pay more attention to the lecture" [S6].
Exams & assignments	"Facing questions from teachers is less stressful in online mode" [S12].
Convenience	"I can learn in comfortable and familiar conditions. In online mode, learning is not impacted by seating in the back rows of physical classrooms" [S15].
Time	"Instead of physically attending 8 am classes, I prefer to attend early morning classes online" [S4].

Table 5. Learning difficulties during online classes

Difficulties	Excerpts
Lack of preparation	"Sometimes in online class, I feel teachers are not prepared enough on how to synchronize different tools" [S13].
Technical issues	"It bothers me that teachers have not been able to connect/present properly due to teacher's equipment problems" [S7].
Addressing doubts	"If the teacher wants to explain our doubts, they cannot write on the whiteboard" [S9].
Connectivity issues	"I think a massive problem during online classes is poor network signal and repeated disconnections" [S3].
Lack of equipment	"My computer does not have a camera. I cannot show my face in an online class even if the professor asks for it" [S6].
Group coordination	"Group presentations with slides can be a huge hassle. Most of the time; we face screen delays" [S7].
Monotonous lectures	"When there is a continuous course in a day, we have to stare at the screen all day long" [S14].
	"Some teachers would teach for three hours straight without a break, which was too much for us to bear" [S10].
Examination is not discriminatory	"It is easier for students to cheat during online exams" [S8].
Other issues	"I live in a small house. While making video recording for final reports, family members interfere during recording" [S3].
	"During preparation of group report, some members did not show up at all & participate in group discussions" [S1].

We asked respondents regarding the learning situations and difficulties while using the online learning mode, and participants were also asked about suggestions for enhancing learning outcomes. On the other side, professors are the key providers of online higher education. Based on their diverse academic backgrounds, professors expressed their perspectives on adapting teaching objectives during virtual teaching. Correspondingly they have illustrated various teaching strategies for better interaction and assessment.

Students' Perspectives

Based on interview findings, we have categorized the responses from students broadly into three categories: learning situation, difficulties and suggestions for improvement.

Learning situation

In the first section of the interview, we tried to understand whether students prefer physical classrooms or online education. Among 16 participants, nine students (56%) preferred physical classroom teaching, whereas the other seven students (44%) preferred online teaching mode. That brings the question of whether the students who liked face-to-face classroom teaching over online education have different characteristics. Students have opined their thoughts on why they like face-to-face classroom teaching compared to online teaching (**Table 3**) and vice versa (**Table 4**).

Although fewer students favored online education, this does not negate the beneficial aspects of online mode. Most students who prefer to study online have strong self-regulation and self-motivation. Some of the main reasons to prefer online education are the flexibility and convenience of using the internet and different digital tools. Pupils who preferred physical classes seem to study in a passive manner preferably. They need physical interaction to help them focus on their studies.

Learning difficulties

In our interviews, students have reflected on diverse challenges and difficulties faced during the epidemic to continue their online education. After qualitative analysis, such challenges were retrieved from the transcribed data (**Table 5**).

Suggestions for improvement

Students illustrated their requirements and recommended crucial suggestions to improve learning outcomes from their point of view (**Table 6**).

Table 6. Suggestions for improvement of online classes

Suggestions	Excerpts
Blended lectures	"Teachers can utilize both live & recorded videos to teach concepts. We can playback them for learning purposes" [S8].
Dividing lectures into chapters	"If teachers divide course videos into chapters, it will be helpful to review, & we can watch videos voluntarily & give feedback" [S2].
Confusion resolution	"I think all teachers should allow us to ask questions outside class via LINE, email, or in teaching platform" [S13].
	"In addition to answering individual questions, teacher can also answer all students' questions in class so that other students can learn together" [S4].
Discussions & interactions	"Interaction with professors helps me to improve concentration" [S5].
	"Some teachers will let group discuss in LINE and ask the students to post the results of the group discussion" [S10].
Weekly assignments	"I think teachers can ask to submit assignments at the end of the week to increase participation in course" [S3].
Open book examinations	"Teachers can use open-book exams" [S9].
	"Teachers can shorten the examination time to prevent students from cheating" [S11].

Table 7. Interviewed professors

Participants	Gender	College
T1	Female	College of Engineering
T2	Female	College of Mechanical & Electrical Engineering
T3	Female	College of Electrical Engineering & Computer Science
T4	Male	College of Design
T5	Female	College of Humanities & Social Science
T6	Female	College of Management

One of the key benefits of online education is easy referencing. In our study, too, students expressed that reviewing the videos and class notes before the exam is beneficial for them. Students proposed many teaching strategies that they thought may improve learning outcomes in online courses, including blended lectures, chaptering lectures, weekly assignments, and regular online meetups. Moreover, students believe that as the teachers cannot find who is cheating during the online mode of examination, open book examination is a fair process for evaluation.

Summary of findings from students' perspectives

Students' responses from our study highlighted their difficulties and necessities while taking online classes and reflected suggestions to improve the online learning experience. Online learning effectiveness is highly dependent on students' motivation. Students who are motivated and diligent in focusing on their studies have preferred online learning and benefitted from it. However, the students who are not that much motivated have mentioned their struggles to cope with online education.

Students' responses from our study indicate that professors designed courses primarily from the perspective of diligent students' requirements. Professors need to consider making learning effective and joyous for all learners. Based on their opinions, the lectures can be recorded to review later, and the online lessons should be divided into chapters. Moreover, students feel that teachers need to provide a space and platform for asking about confusion outside the online class hours. Classes should be designed to increase interaction such as discussion and practical assignments, to enhance students' concentration for those who struggle with a lack of attention and anxiety.

Teachers cannot assume that students understand and access all technologies simply because they have grown up with more prevalent and powerful digital technologies. Professors need to consider the technological limitations and problems students face during online education. Based on students' responses, we can infer that professors should limit the use of technology when creating and delivering courses.

Professors' Perspectives

The second section of the interview conveys the professors' perceptions of online education approaches at Taipei Tech during the COVID-19 epidemic. Our study seeks to understand how technology and remote learning modalities were used during school closures and their influence on students' and teachers' perceptions of learning and teaching. Three categories became apparent in interviews with teachers when they reflected on their online teaching experience due to the COVID-19 pandemic: Overall attitude, teaching objectives and teaching strategy. The demographic characteristics of interviewed professors are presented in **Table 7**. Out of six professors who participated in our studies, five of them are female faculty members.

Overall attitude

We tried to comprehend teachers' perspectives toward online teaching. Six professors from diverse academic backgrounds gave insights about their online teaching experience (**Table 8**). Even after this pandemic, it may require incorporating online teaching in designing curriculums. It is crucial to apprehend what teachers think about the future of online education. To answer questions of if they are willing to teach online in future and under what circumstances, teachers provided their perceptions of some possibilities (**Table 9**).

Teaching objectives

We have asked the professors whether they have achieved their teaching objectives while teaching online. Consequently, teachers have depicted various difficulties they have experienced in online teaching for both lecture-based and practical courses, along with suggestions to improve these problems (**Table 10**).

Table 8. Overall attitude towards online teaching

Perceptions	Excerpts
Subject variability	"Well! in my subject, it is not suitable, and I do not prefer online teaching. Though, I cannot reject the fact that, depending on subject attributes, in some cases, online teaching is good" [T1].
Lack of experience	"I am more used to taking classes in physical classrooms" [T2].
Unable to see students' expressions	"It is frustrating that I cannot see students' reactions or their enthusiasm in online classes" [T2].
Difficulty in reaching students	"It is difficult to provide timely assistance to students because we cannot see what is happening to them, and it is difficult to understand their needs" [T4].

Table 9. Possibilities of willingly teaching online

Possibilities	Excerpts
Merging online & classroom teaching	"We need to think about where we can adopt synchronous and asynchronous teaching methods and how they two can be used interchangeably" [T1].
Future emergency	"Maybe I can use this flexible teaching method in the future in case of travel or illness" [T2].
Distance learning	"Online teaching will be an excellent tool for distance learning with overseas schools" [T4].

Table 10. Teaching difficulties during online classes

Issues	Excerpts
Lecture-based courses	
Lack of experience	"I have not yet mastered the online teaching skills, and not sure that I will be able to achieve the same impacts of the physical classes" [T1].
Low interactivity	"In virtual classroom, interaction with students is very less. And there is less variation in classroom activities" [T1].
Space limitation	"I cannot use multiple whiteboards to present information while teaching online" [T5].
Designing courses	"Courses need to be redesigned & adjusted, & more activities can be designed in future for implementation" [T6].
Practical courses	
Limitations to doing hands-on training	"Students can only do 60-70% of the hands-on work online" [T4].
Unable to supervise	"… cannot see how much students are learning while doing practical procedures. It is tough to assist students online" [T4].
Lack of accessibility to equipment	"It is hard to teach practical stuff online as students have no access to those machines in labs" [T4].
Online interaction	
Subject variability	"Depending on different subject attributes, targets to achieve teaching objectives will be different" [T5].
Problem-based learning	"… course uses PBL (problem-based learning) & is conducted in small groups, is easier to conduct" [T3].
Technical issues	"Sometimes students cannot concentrate as network connectivity is poor from their side or maybe their microphone, camera is disturbing" [T1].

Teaching strategies

Teachers discussed various approaches to increase students' engagement by creating connections with students and interacting with them to promote appropriate online education practices based on online resources, time management, course designing and evaluations (**Table 11**).

Summary of findings from professors' perspectives

With the sudden impact of the COVID-19 pandemic, teachers needed to shift their teaching approaches entirely online without much preparation. The major challenge for professors to optimize the online teaching experience is understanding how to utilize digital tools and technological infrastructure efficiently. Professors need to be trained and develop their abilities to use virtual teaching and learning tools.

Students who are learning online may not progress at the same pace as they used to progress in traditional classrooms. Professors must consider these factors, alter their teaching expectations, and give regular valuable feedback to students. When students cannot meet due to COVID-19 social distancing requirements, they are at a greater risk of feeling alienated. To lessen feelings of isolation as well as to promote an efficient online learning teaching experience, teachers should seek to develop strong interactions with and among students using chat rooms or other online tools to allow easy accessibility to reach teachers.

Professors need to think about designing course structures and developing assignments that will increase students' focus and engagement to complete tasks or quizzes. Professors should take advantage of beneficial features such as off-campus meetings, merging videos in live lectures, time flexibility, meeting style discussions, online resources, collaboration, and sharing multimedia resources to make the online lessons more exciting.

DISCUSSION, IMPLICATIONS, AND LIMITATIONS

Online education is not new. However, the COVID-19 pandemic made it more relevant. We conducted this research at a time when higher educational institutes were offering online courses. The higher education sector is confronting a multitude of obstacles. Universities are required to offer courses that were previously taught in physical classrooms,

Table 11. Teaching strategies

Approaches	Excerpts
Online resources	
Availability of online resources	"I upload recorded videos for students to watch on their own time" [T3].
Digital tools	"I ask my students to collaborate and share multimedia resources, writing assignments using Google Forms & Google Docs in my class" [T5].
Time savings	
Time flexibility	"In my course, I encourage students in problem-based learning. That saves their time, and they can do it anytime they want" [T3].
Course meetings	"… classes conducted in the form of a meeting, and other students will also participate" [T4].
Course interaction	
Shortening time	"It is better to take classes for short durations and take breaks to avoid fatigue" [T5].
Assigning tasks	"I ask students to complete the tasks according to the course content and submit them before the end of the course to improve students' concentration" [T2].
Use of chat rooms	"Nowadays, all students use chat rooms. Many students do not like to answer verbally. Before final exams, many students asked questions in chat rooms. Quiet students also feel free to participate in discussions by using chat rooms" [T1].
	"I assume previous interactions in physical class helped in online interactions. … I prefer LINE and Google Meet for group discussions" [T2].
Test & evaluation	
Multiple exam papers	"I use multiple exam papers, and the questions are relatively difficult. Zuvio is pretty helpful in setting exams with time limits" [T1].
Dealing plagiarism	"Many teachers have found plagiarism during the examination of the online course" [T6].
Assessing students	"Many of us are assigning students to prepare written or oral reports. Asking for peer assessment between groups. And, if possible involved external teachers in the online assessment of student reports" [T4].

and the transition from physical classrooms to a completely online educational environment raised many challenges. Although online learning is at a nascent stage and is associated with many technological and social complexities, online education is promising. It has the potential to address many challenges in higher education. The current study investigates teacher and student perceptions of the benefits, drawbacks, and suggestions for online higher education in the context of Taiwanese universities.

It is essential to understand the needs of students, what assistance can be provided and how the effectiveness of learning can be enhanced. Although the abrupt transition to digital education was difficult for the students, it seems like they rapidly adjusted to the unfamiliar setting. In today's world, the young generation uses online tools more actively. Based on our findings, we can convey that they are open-minded, responsible, keen to share resources, willing to emphasize their personal issues, and polite. Teachers can leave some space for students to think creatively, guide them to answer questions, and design appropriate activities in the curriculum to achieve the teaching objectives. While doing activities or assignments in groups, the students preferred smaller groups with known classmates rather than being allocated to groups at random.

From the teacher's perspective, interaction with students as well as other teachers regarding teaching ideas is crucial. Teachers need to consider taking feedback on their own offered online classes. Teachers can learn and follow others' ways of teaching; however, that may not always be applicable to their teaching process, as based on different situations and domains, teachers need to adapt their own teaching style and approach. Teachers may be benefitted by forming formal or informal groups, joining communities online with other fellow professors to discuss teaching activities and perhaps doing online training for using digital modalities efficiently to make learning engaging and effective for students.

Prior planning and preparation for online teaching are necessary. Teachers must be adequately trained and equipped with the essential knowledge and competence to maximize their online teaching effectiveness. Similar insight has been suggested in a recent study among university teachers at one Spanish and one Polish university, illustrating that digital teaching competency should be improved in the context of university education (Sánchez-Caballé & Esteve-Mon, 2022). When teachers set clear goals, courses become exciting and relevant, leading to effective teaching and better interaction with students.

A successful online higher education system relies on digital technologies. Along with adapting to existing online solutions, colleges and universities need to evaluate and consider making their own LMS more effective. While we are bound to interact and learn online due to COVID-19 and maybe beyond that, teachers need to understand these emerging digital modalities to use them effectively for teaching. In online education, digital tools with the internet are essential. However, professors need to consider students' perspectives and possibly minimize technology needs.

Because of COVID-19, we had the opportunity to learn on a large scale what professors from different colleges think about online learning. Although there have been several studies on online higher education adoption, the current study intends to add to the existing literature by analyzing the primary problems and factors impacting the effective adoption of online learning in Taipei Tech, Taiwan, which may serve as a model for other Taiwanese and international higher educational institutions. The findings from this study can be used as a reference for online course design. This research study looked at various online education approaches, problems, and recommendations by professors and students. Our findings emphasize possible strategies for teachers to engage students. The study also highlights the advantages of utilizing various technologies to diversify the curriculum and

maximize the involvement of all students. Suggestions from this study can assist university policymakers, professors, and students since the findings illustrate a realistic image of the current online higher education system and can be used as a guideline to improve the learning and teaching effectiveness among students and teachers for both online and face-to-face learning systems. Online courses will become the new normal, not necessarily because of the epidemic. Due to the massive technological evolution and societal inclination towards technology, online education will be evolved and change higher education in the coming years.

A few points need to be considered regarding the generalization of the findings. Since the research participants were from six different colleges at a single public higher education institution in Taiwan, the study results are only relevant to similar circumstances. More studies based on our findings should be conducted across Taiwan and other countries to ensure generalizability considering countries' socio-economic, cultural and infrastructural disparities. Despite the constraints, the conclusions of this study provide insight into the benefits, drawbacks, and suggestions for improving online learning, which is a pressing need.

CONCLUDING REMARKS

By the time we are writing this article, COVID-19 is very much present among us, so as the rules and regulations to maintain social distancing for staying safe. Our research provides students' and teachers' viewpoints on a unique era of time in higher education globally. Technological innovations are incredibly helping various education sectors, including higher education. Privacy and security concerns regarding the software we are using for online education need further investigation. Emerging techniques such as flipped classrooms, augmented realities, and gamification might be used to teach practical and theoretical courses online, and their impacts could be investigated. Ongoing research during the COVID-19 pandemic provides challenges and possibilities for online teaching and learning in higher education related to socio-economic, cultural and infrastructural differences. More research is required to address these challenges for effective policies to implement online learning among diverse domains in higher education. Many research studies, including the current one, reciprocated various advantages of online higher education along with the concerns. Educational policymakers, researchers and educators need to continually evaluate and consider how beneficial aspects of online education can be incorporated into the traditional education system even after the pandemic. This COVID-19 crisis could be an opportunity for educators and policymakers to rekindle the need to explore online education, learning opportunities, rebuild educational structures, and develop efficient academic practices to create a compelling and sustainable learning ecosystem for today's young generation.

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