# Changes in university students' behavioral intention to learn online throughout the COVID-19: Insights for online teaching in the post-pandemic era

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## Abstract

Many researchers investigated university students' behavioural intention to undertake online courses during COVID. However, few examined how students' intention might change throughout COVID by incorporating their learning capability and approaches. The universities in China went through a process from lockdown in February to reopening in September 2020. It provided a unique context for university students in China to experience emergent online learning for approximately six months before returning to normal face-to-face or blended learning on campus. The researchers conducted a questionnaire survey among 193 Chinese university students to investigate the changes in their behavioral intention to learn online throughout COVID. Additionally, the researchers explored the relationships between the participants' behavioral intention and the factors of learning capability in general, application of specific online learning strategies, online course engagement levels, and academic performance. It was found that the participants' intention to study online significantly increased during COVID and then slightly decreased after the university reopened. The participants' intention of online learning after COVID was predicted by their prior intention, learning capability, application of online learning strategies, and online course engagement. The participants' perceptions about online learning revealed that, when choosing future course delivery modes, they would a) reflect on their own disposition, capability, and needs, b) compare different learning modes, and c) examine course quality and teachers' competency. The participants also shared advice regarding their expectation of future online courses which may help shape university educators' pedagogical practices and provide insights for university online and blended course delivery from learners' perspectives.

**Keywords** Behavioral intention · General learning capability · Application of online learning strategies · Online course engagement · COVID-19

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# 1 Introduction

## 1.1 Background of the study

With the advent of the COVID-19 pandemic declared by the World Health Organization (WHO) at the beginning of 2020, there have been more than half a billion confirmed cases of COVID globally by July 2022 (WHO, 2022). As a result, almost all educational sectors across different age levels, including higher educational institutions, were shut down worldwide in 2020 (Adedoyin & Soykan, 2020; WHO, 2020). During COVID, both teachers and students faced significant challenges in adapting to emergency remote teaching (ERT) due to the rapid transition of course delivery. Such a shift to online learning is different from regular online courses (e.g., MOOCs before COVID), as the latter are initially and intentionally designed to be delivered entirely online and involve a significant period of planning and design (Hodges et al., 2020; Yilmaz & Kostur, 2021). On the contrary, regarded as a temporary shift to an alternate delivery mode, ERT applies fully online teaching solutions for instruction that would otherwise be delivered via face-to-face (F-T-F) or blended learning mode (Hodges et al., 2020).

The situation of ERT during COVID generally resulted in chaotic learning environments, where teachers hastily migrated their course content to an online context and students were forced to shift to online learning (Schultz & DeMers, 2020). Whether feeling comfortable with online teaching or not, the teachers had to transfer their courses online within a limited time frame. From students' perspectives, ERT could result in cognitive overload and become challenging for those who were unconfident in technology use or lacked strong learning capability (Bower, 2019). As adult learners, university students faced significant adjustments due to the loss of daily course routines and regular social interactions with teachers and peers, keeping themselves on track and organized. Moreover, the students with fewer online learning experiences might suffer from difficulty using course platforms, applying learning strategies effectively, keeping themselves up with course schedules, and so on (Crooks et al., 2020).

Numerous studies have explored university students' behavioral intention to learn online that were associated with several factors, such as instructor and learner characteristics, online teaching competency, online course and platform quality, online interaction and support (e.g., Brahmasrene & Lee, 2012; Chang et al., 2017; Lee, 2010; Zhou, 2016). However, little empirical research examined how university students' online learning intention would vary and how students' learning capability and skills, course engagement and performance, and online learning intention would relate to each other over COVID.

## 1.2 Contextualized research environment: Higher education in the Chinese context

A full academic year in a Chinese university starts in September and ends in July the following year, which indicates that an academic year in the universities in China goes through two years. Take a Chinese university's 2019–2020 academic year as an example, which includes two semesters starting from September 2019 and ending in September 2020 (Table 1).

The majority of full-time students in the universities in China are high school leavers and live in the provided student accommodation on campus. Before the COVID outbreak in March of 2020, Chinese universities delivered courses through F-T-F or blended teaching on campus. During the pandemic, all universities were forced to close down on-campus activities, and all courses were delivered online until July 2020. In September 2020, most universities in China (including the one in the present study) were reopened, and students returned to study face-to-face or through a blended mode on campus.

Therefore, university students in the 2019–2020 calendar year had experienced a disrupted learning environment. It provides a unique opportunity for the researchers to investigate university students' behavioral intentions during an interrupted calendar year, when the students were forced to undertake more online courses, thus allowing the researchers to analyze student perception before, during, and after the COVID lockdown. There is currently a dearth of research examining the variation of student intention toward online learning throughout the COVID lockdown period in China, which this study aims to fill. The present paper explored 193 university students' behavioral intention to learn in an online mode (compared with F-T-F and blended learning modes) before, during, and after the COVID lockdown. In addition, the researchers attempted to investigate how the students' general learning capability, application of online learning strategies, online course engagement level, and academic performance would influence their willingness to learn in an online mode after the COVID lockdown.

**Table 1** Timetable for the 2019–2020 Academic Year

| Semester and break | Duration |
|---|---|
| The first semester | The beginning of September in 2019 – the beginning of January in 2020 |
| Winter Break | January in 2020 – February in 2020 |
| The second semester | The end of February in 2020 – the end of June in 2020 |
| Summer Break | June in 2020 – September in 2020 |

## 2 Literature review

The concept of people's intention of specific behavior was proposed based on a series of theories, including the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), the theory of planned behavior (TPB) (Ajzen, 1985), and perceived behavioral control (Ajzen, 1991). Regarded as the intention of performing certain actions, people's behavioral intention is affected by their attitude, subjective norm (perceived social pressure), and control of cognitive behavior (e.g., perceived easiness and difficulty). People's behavior can be determined by their behavioral intention to emit the behavior. From this sense, intention highlights people's likelihood of behaving in a certain way (Fishbein & Ajzen, 1975). Therefore, students' intention to learn in a specific learning mode (e.g., F-T-F, online, or blended learning mode) can be regarded as their willingness and likelihood to receive instruction in this learning mode.

The existing research on university students' online learning during COVID raised a variety of topics covering different aspects of online learning and teaching, including:

- the impact of COVID on teaching and learning (Ali et al., 2021; Zhang et al., 2020)
- challenges and opportunities brought by online education (Adedoyin & Soykan, 2020; Azubuike et al., 2021)
- the gaps between developing and developed countries or among developing countries (Azubuike et al., 2021; Kamal et al., 2020; Mishra et al., 2020; Oyedotum, 2020)
- technical usage (Chatterjee & Chakraborty, 2020)
- student characteristics and personality traits (Tavitiyaman et al., 2021)
- students' learning and psychological needs (Shah et al., 2021; Wong, 2020)
- students' online course experiences (e.g., interactions with learning content, teachers, and other students) and course engagement (e.g., frequency of course participation or time devoted to learning) (Adnan & Anwar, 2020; Gonzalez-Ramirez et al., 2021; Luan et al., 2020)
- students' learning motivation (Adnan & Anwar, 2020; Baber, 2021; McPartlan et al., 2021)
- students' course satisfaction (Saxena et al., 2020)
- students' online learning outcomes (Adnan & Anwar, 2020; Gonzalez et al., 2020)
- students' online learning attitude or intention (Aguilera-Hermida, 2020; Baber, 2021; George, 2020; Gonzalez-Ramirez et al., 2021; Pal & Patra, 2020; Tang et al., 2020; Unal & Uzun, 2021)
- online learning approaches (George, 2020; Gonzalez-Ramirez et al., 2021; Khan et al., 2021; McPartlan et al., 2021; Tang et al., 2020)
- students' self-management to cope with the pubic crisis (Hadar et al., 2020)
- teachers' characteristics and teaching competency (Baber, 2021)
- parents' involvement and support (Azubuike et al., 2021), and so on.

The following sections depict the concepts of different learning modes and current research findings on university students' intention to learn online during ordinary online teaching and COVID, followed by an argument on the significance of the present research.

## 2.1 Concepts of face-to-face, online and blended learning

Before the widespread of information and communication technologies (ICTs), learning and teaching activities occurring through F-T-F contact in a physical environment (e.g., a classroom) had remained a major method for students to acquire knowledge and skills in higher education. F-T-F learning is a mode of learning occurring in a physical context, where a teacher talks to a group of students, all together in a synchronous learning environment (i.e., at the same time and in the same place), and the students acquire knowledge from the teacher or through books and other teaching aids (Black, 2002). Students complete their learning activities by listening to teachers' instructions, having F-T-F discussions or group work with peers, and completing hands-on practice in classrooms.

Since the introduction of ICTs, especially after the Internet technologies were widely used in education, students can learn through enriched resources of multiple formats, asynchronous and synchronous interactions supported by online learning platforms, social networking tools, mobile technologies, and so on. Online learning refers to a mode of learning occurring in a context where students learn from learning management systems, supported by the Internet technologies, and communicate with their teachers and other students through synchronous and asynchronous communications. In essence, online learning stands for learning occurring entirely online. Thus, it does not include F-T-F contact between students and teachers or among students in physical learning contexts (Ally, 2004; Lee & McLoughlin, 2011).

Both F-T-F and online learning have strengths and limitations. F-T-F learning provides a familiar and comfortable environment for most students where they can have immediate interactions with their teachers and peers. For many university students, F-T-F learning reflects the standard instruction during the students' schooling. However, F-T-F learning lacks flexibility as it is constrained by time and location (Black, 2002; Zhang et al., 2004). Flexibility can be one of the most important advantages of online learning, which benefits students with more control over their learning pace, enriched learning resources, and extended interactions with their teachers and other students (Song et al., 2004; Stansfield et al., 2004). However, online learning creates several issues, such as digital gaps between the learners with different economic and social backgrounds, insufficient teachers' support, feeling of isolation, difficulty in catching up with online course schedules, technical issues, and so on (Azubuike et al., 2021; Kamal et al., 2020; Song et al., 2004; Vonderwell, 2003).

A blended mode of learning is considered to optimize the advantages of both F-T-F and online learning to offer students flexible access to course content, extend interaction online, and remain F-T-F instructions in classrooms (Dziuban et al., 2004). Blended learning is a mode of learning that combines F-T-F instruction and

online learning and supports students' learning with F-T-F and online communication and various online learning resources and tools (Lei, 2010; Macdonald, 2006; Rudestam & Schoenholtz-Read, 2009). Teachers may assign their online and F-T-F teaching sessions differently based on particular subject areas, target students, and learning objectives of blended courses.

## 2.2 University students' behavioral intention to learn online during ordinary online teaching

University students' behavioral intention of online learning is not a new topic before COVID lockdown. Extant studies in this area were carried out based on various theories, including the technology acceptance model (TAM), information system (IS) success model, task-technology fit theory (TTF), expectation-confirmation model (ECM), cognitive model (CM), social cognitive theory (SCT), motivation theory, technology continuous theory (TCT), self-determination theory (SDT), expectancy-value model, theory of planned behavior (TPB), theory of flow, and fairness theory (e.g., Adams, 1965; Ajzen & Fishbein, 1980; Aljukhadar et al., 2014; Atkinson, 1964; Bandura, 1977, 1986; Bhattacherjee, 2001; Brown, 2007; Csikszentmihalyi, 1975; Davis et al., 1989; Eccles, 2010; Liao et al., 2009; Oliver, 1980; Petter et al., 2013; Ryan & Deci, 2000).

The studies relevant to university students' online learning intention during normal teaching covered a number of factors, including students' perceptions and attitudes (Chang et al., 2017; Ifnedo, 2017; Joo et al., 2018), online learning experiences that were interpreted in terms of perceived online course quality and various types of online interactions (Brahmasrene & Lee, 2012; Chou et al., 2015; Dağhan & Akkoyunlu, 2016; Guo et al., 2016; Huang et al., 2017; Lee et al., 2009; Mohammadi, 2015), learning motivation (Kim et al., 2017; Zhou, 2016), and learning capability and application of specific learning strategies (Hood, 2013; Lee, 2010; Tsai et al., 2018).

## 2.3 University students' behavioral intention to learn online during COVID

Online learning during COVID is a rather forced learning mode more than a planned one, leaving students with no choice in terms of their preference for certain course delivery mode (Baber, 2021; Bao, 2020). The studies on university students' online learning intention during COVID mainly focused on their online learning attitude, perception, enjoyment, readiness and willingness, technology use and acceptance, online learning experience, and student and teacher characteristics (e.g., Baber, 2021; Pal & Patra, 2020; Unal & Uzun, 2021). For example, Unal and Uzun (2021) extended the technology acceptance model (TAM) with the factors of subjective norms, output quality, perceptions of external control, perceived enjoyment, technological complexity, and self-efficacy. The researchers found that university students' intention to use a specific online learning platform (i.e., Edmodo) was significantly predicted by their attitude and perceived usefulness and ease of use. Unal and Uzun

pointed out that the participants' experiences might be unstable while using different learning platforms and vary over time and across different courses.

Pal and Patra (2020) studied university students' actual use of online video resources during COVID based on the theories of TAM and TTF. The Partial Least Squares (PLS) model revealed that the students' actual use of video-based learning resources was directly predicted by their attitude toward using video as learning resources and indirectly influenced by their perceived ease and usefulness of these resources. Furthermore, the impact of task-technology fit (i.e., the fit between the video technology and content and the student's learning goals and needs) on the students' actual use of the videos was mediated through their attitude and perceived ease and usefulness of the video resources.

Baber (2021) investigated the relationships between students' characteristics (i.e., motivation, mindset, and online collaboration), instructor characteristics (i.e., attitude, competency, and online interaction), perceived ease of use and usefulness, and students' behavioral intention to learn online. Baber ran Partial Least Squares Structural Equation Modeling (PLS-SEM) and found that students and instructor characteristics and technology acceptance significantly contributed to the students' online learning intention. Their perceived severity of COVID mildly moderated the relationship between the students' technology acceptance and behavioral intention.

In addition to the above studies, some researchers compared university students' willingness to undertake different learning modes during COVID (Aguilera-Hermida, 2020; Gonzalez-Ramirez et al., 2021; Khan et al., 2021; McPartlan et al., 2021; Reinhold et al., 2021). For example, Aguilera-Hermida (2020) found that the students' willingness to learn in an F-T-F context significantly correlated with their struggle with adapting to online learning. Blizak et al. (2020) examined 380 university students' perceptions of online learning during COVID and found that the majority of the students showed a negative perception of online learning and would like to choose F-T-F instruction. Among the students, 64% and 29%, respectively chose F-T-F and blended learning. Gonzalez-Ramirez et al. (2021) found that the students considered F-T-F learning more effective than online learning.

However, inconsistent findings were identified in other research on university students' online learning intention during COVID. Hamilton et al. (2020) found that 47% of the participants in their study preferred live lectures. Another 30% favored a blend of "live" and recorded lectures. Khan et al. (2021) investigated 103 medical students' online learning experiences during COVID. Nearly half of the students (50 out of 103) would like to learn in a blended environment, the same portion favored F-T-F learning, and the rest would choose online learning. The students' feedback on the online course was categorized as engaging, enjoyable, and motivating learning. Muthuprasad et al. (2020) examined the students' perceived effectiveness of online learning compared to F-T-F learning and found that the students held neutral attitudes toward online learning.

The discrepancy in the existing findings of university students' behavioral intention to learn in different modes during COVID may result from their diverse online learning experiences. Ali et al. (2021) found that differences in students' perception of taking online learning mode might be the consequences of their experiences of various online courses and interactions with different instructors online. McPartlan

et al. (2021) differentiated the reasons provided by 999 university students regarding their willingness to undertake online or F-T-F courses. The researchers identified overarching themes generalizing the reasons for 219 participants' intention to learn online, including the preference for flexibility, self-paced learning and online peer interactions, and university constraints on enrollment.

Besides comparing students' behavioral intention of online and F-T-F learning, researchers explored the variation in university students' willingness or enjoyment to learn online during COVID. For instance, Reinhold et al. (2021) studied the changes in university students' preference for online learning on completing an online course during COVID restrictions. The researchers found that the students with lower levels of ICT attitudes displayed a marginal increase in their preference for online lectures. In contrast, the other students with more favorable toward ICT revealed decreases in their choice of online lectures. Reinhold interpreted that 65% of the participants dropped out of the course. The participants who lowered their appreciation of online learning for math were among the dropouts. Reinhold's research was limited to a small percentage of the participants (35%), and the other participants' preference for certain learning mode was not tapped.

## 2.4 Significance of the study

A large number of studies focused on the relationships between university students' behavioral intention to learn online and several factors, such as online learning experience, course quality, teacher and student demographic backgrounds, self-regulatory learning strategies, and so on. However, few empirical studies examined the variation of students' behavioral intention to learn online during COVID, incorporating students' capability and strategies to learn effectively, course engagement, and academic performance. Capability is defined as an overall human quality that integrates knowledge, skills, personal attributes, and understanding used appropriately and effectively in either familiar contexts or new and changing circumstances (Stephenson, 2000). Learning capability includes an effective as well as a cognitive dimension (Higgins et al., 2007). Therefore, students' learning capability in the present study can be regarded as an overall ability or quality that enables them to learn effectively and successfully in various circumstances. Students' application of learning strategies focused on their skills of applying particular approaches to learn effectively (e.g., Hofer et al., 2021).

The present study was conducted based on the limitations identified in the existing research on university students' behavioral intention to learn online: a) Few studies explored university students' intention to learn online (compared with other learning modes) across three-time points of before, during, and after the COVID; and b) Few studies investigated how students' learning capability, application of specific online learning strategies, course engagement, and academic performance may change throughout COVID and how these factors would influence their online learning intention after COVID. Therefore, the present paper aims to investigate the following research questions:

1) How will university students' behavioral intention to learn online (compared with F-T-F and blended learning), learning capability in general, application of online learning strategies, online course engagement, and academic performance change before, during, and after the COVID lockdown?
2) Will learning capability in general, application of online learning strategies, online course engagement, and academic performance significantly influence university students' online learning intention after the COVID lockdown?

## 3 Methods

### 3.1 Research design

As discussed in Section 1.2, the unique context in Chinese universities provided a chance for the researchers to investigate students' behavioral intention to undertake university courses in different modes at different stages of COVID. In the present study, the researchers administered a questionnaire survey with multiple-choice and open-ended questions among a group of Chinese university students. The participants were asked to reflect on their learning experience in F-T-F, online, and blended modes before, during, and after COVID that was respectively labeled as Time 1 (T1), Time 2 (T2), and Time 3 (T3). The multiple-choice questions examined the students' learning capability in general, application of online learning strategies, online course engagement, academic performance, and behavioral intention to undertake the three learning modes at T1, T2, and T3. The open-ended questions further asked the students to provide reasons for choosing online learning mode at T3 and expectations of future online courses.

In order to describe and explore human behavior among a large population, questionnaires are suitable to obtain information about participants' feelings, thoughts, attitudes, perceptions, and behavioral intentions. In addition, researchers can ask questions about the participants' present, past, and future in a questionnaire survey (Johnson & Christensen, 2012; Singleton & Straits, 2009). This serves the present research purpose of promoting the participants to reflect on their learning experience and perception from T1 to T3 and report their intention to learn online throughout COVID.

### 3.2 Participants

A hundred and ninety-three participants, who were enrolled in "Educational Technology" and "Modern Distance Education" in the first semester of the 2020–2021 academic year, participated in the study (Table 2). All the participating students were in classes of 30 to 40 students per class. The participants included 35 male (18%) and 158 female students (82%). The majority (55%) were between 21 to 25 years old, another 44% were between 18 and 20, and 1% belonged to the age group between 26 and 30. Among the participants, 40%, 17%, 15%, 14%, and 8% respectively specialized in Educational Technology, Music Education, English

**Table 2** Semester schedule and course delivery modes in the university in the present study

| Semester and break | Course delivery modes | Duration |
|---|---|---|
| The first semester in 2019–2020 Academic year | On-campus normal F-T-F and blended teaching before COVID lockdown | The beginning of September in 2019 – the beginning of January in 2020 (T1) |
| Winter break | | The beginning of January in 2020 –The end of February in 2020 |
| The second semester in 2019–2020 Academic year | ERT during COVID lockdown | The end of February in 2020 – the end of June in 2020 (T2) |
| Summer break | | The end of June in 2020 – beginning of September in 2020 |
| The first semester in 2020–2021 Academic year | Resumption of on-campus F-T-F and blended teaching after COVID lockdown | The beginning of September in 2020 – the beginning of January in 2021 (T3) |

Literature, TESOL, and Politics. The rest of the participants (6%) majored in Biological Sciences, Chemistry, Chinese, and Physical Education. Sixteen per cent of the participants were postgraduate students, and 83% and 1% were, respectively, learning toward Bachelor's and Diploma degrees.

All participants had undertaken F-T-F, online, and blended courses before COVID. During the campus lockdown, all participants participated in emergent online learning. As described in the above section, the universities in China applied ERT proximately from February to June in 2020 and were reopened to resume on-campus teaching after September 2020. The participants in the study returned to F-T-F or blended learning on campus in September 2020, when education in China started to enter the post-COVID era (Table 2).

### 3.3 Instruments

The questionnaire survey included four sections gauging the information about a) the participants' demographic background, b) learning capability in general, application of online learning strategies, and online course engagement from T1 to T3, c) academic performance and behavioral intention to undertake more online courses from T1 to T3, and d) perception of online learning and expectation of future online courses. In the second and third sections, the participants did not need to recall their experiences and intention of different learning modes in any specific course or subject area, but in university courses in general. The following paragraphs provide detailed information about the survey questions.

The first section gauged participants' demographic information, including their gender, age level, university degree they studied toward, and majors.

The second section requested the participants to reflect on how capable they were of learning effectively in general, their skills of using specific online learning strategies, and levels of online course engagement at T1, T2, and T3. The abbreviated scales addressing the participants' learning capability in general and application of online learning strategies were generated based on the instruments developed by Barnard et al. (2008), Lan et al. (2004), Pintrich et al. (1991), Pintrich et al. (1993), and Pintrich and De Groot (1990). The scales measuring learning capability tapped students' concentration on learning, effort and energy input in learning, creativity and persistence in learning, and the accuracy of executing learning strategies with a three-point Likert scale from low, medium, to high levels.

The participants' application of specific online learning strategies was rated from "not skillful at all" to "very skillful" on a five-point Likert scale. These items described specific approaches taken by the participants to help them learn better online, including "locating online learning resources and information", "evaluating, managing, synthesizing, and organizing online learning resources", "communicating with teachers online", "communicating with other students online", and "accomplishing teamwork through collaboration". At the end of Section Two, the participants were asked to rate their online course engagement levels from low, medium, to high based on their overall online learning experiences at T1, T2 and T3. The researchers provided a detailed interpretation of the item of online course

engagement to the participants as the level of their effort and time they devoted to online learning in general. University students in China are required to complete full time studies, equivalent to 40 h per week, which includes interactive classes hours and self-studying time per week. Therefore, the time spent in online learning over 40 h per week could be regarded as "high", and the duration between 20 to 40 h and below 20 h every week were respectively considered as "medium" and "low".

In the third section, the item measuring the participants' academic performance requested them to rank their overall academic achievement at T1, T2, and T3 on a five-point Likert scale from "far below the average" to "far above the average". Academic performance was based on students' self-reported GPA (Grade Point Average), with the participants estimating their ranking within their class. Then, all the participants were asked to rate their intention to learn in F-T-F, online, and blended contexts at different stages throughout COVID on a five-point Likert scale from "strongly disagree" to "strongly agree" (e.g., "I was willing to take more online courses before COVID", "I was willing to take more online courses during COVID", "I am willing to take more online courses in future").

The last section of the survey contained two open-ended questions addressing the participants' perception of online learning during the COVID lockdown and expectations of future online courses. The participants' responses to these questions provided more insights about their online learning experiences during COVID and suggestions to further improve online courses from learners' perspectives.

### 3.4 Procedure

After obtaining consent from the University Ethics Committee, the staff teaching the courses of "Educational Technology" and "Modern Distance Education" were contacted, and consent of the teaching staff was obtained. With help from the staff, all students were informed about the research project, including research aims, procedure, and confidentiality of data storage and publication. One hundred and ninety-three students gave consent and completed the online questionnaire survey in the third and fourth weeks of the semester. The participants' personal information was not identified in any form of the research report.

### 3.5 Data analysis

The researchers performed quantitative and qualitative analyses in the present study. Factor analyses were conducted to ensure the internal consistency of the factors of general learning capability and application of online learning strategies. SPSS and SmartPLS 3.3.7 were used to analyze the relationships between the participants' behavioral intention to learn in online, F-T-F, and blended modes and the factors of learning capability, online learning strategy application, online course engagement, and academic performance. First, due to a non-normal distribution in the factors of intention to learn in F-T-F, online, and blended learning environments, Friedman Test was used to investigate the changes in the participants' intention to learn in different modes from T1 to T3. Wilcoxon Signed-Rank test with Bonferroni correction further determined if two measurements from the

**Table 3** Factor analysis

|  | KMO | Cronbach's Alpha | AVE | Number of items | Natural mid-point |
|---|---|---|---|---|---|
| Application of online learning strategies | 0.82 | 0.88 | 0.56 | 8 | 3 |
| General learning capability | 0.88 | 0.88 | 0.62 | 6 | 2 |

*N* = 193

**Table 4** Number of the participants intending to undertake different learning modes

|  | T1 | T2 | T3 |
|---|---|---|---|
| F-T-F learning | 134 | 88 | 125 |
| Online learning | 73 | 115 | 107 |
| Blended learning | 124 | 105 | 137 |

*N* = 193

participants' intention would be significantly different from each other. The above two tests are nonparametric alternatives to determine whether there would be a statistically significant difference between the means of three or more groups in which the same subjects show up in each group (Conover, 1999; Scheff, 2016). Second, Pearson correlation test was used to examine the correlation coefficients between the participants' behavioral intention, learning capability, online learning strategy application, online course engagement, and academic performance. Finally, as a preferred technique in exploratory research studies, partial least squares structural equation modeling (PLS-SEM) was run to identify the relationships between the above factors (Hair et al., 2014). The alpha level as a significance criterion was set as 0.05.

Regarding the participants' responses to the open-ended questions, the researchers generated and defined themes from their responses by coding the text data. The coding was completed and checked by all the researchers to make sure that a) the coding processes between the researchers were consistent and b) the data under these codes and themes were precise and relevant to the questions. Frequency tables were used to provide detailed indicators of the identified themes.

# 4 Research findings

## 4.1 Factor analysis

The researchers performed factor analysis on the variables contributing to the participants' learning capability and application of online learning strategies. A

**Table 5** Frequencies of the intention of different learning modes

|    | Behavioral intention | Mean | Median | SD | Skewness | Kurtosis | Minimum | Maximum |
|----|---------------------|------|--------|------|----------|----------|---------|---------|
| T1 | F-T-F learning | 3.67 | 4.00 | 0.71 | -0.83 | 0.52 | 2 | 4 |
|    | Online learning | 3.06 | 3.00 | 0.94 | -0.05 | -0.93 | 1 | 5 |
|    | Blended learning | 3.62 | 4.00 | 0.80 | -0.53 | -0.14 | 2 | 5 |
| T2 | F-T-F learning | 3.16 | 3.00 | 1.12 | -0.15 | -0.98 | 1 | 5 |
|    | Online learning | 3.45 | 4.00 | 1.04 | -0.56 | -0.52 | 1 | 5 |
|    | Blended learning | 3.45 | 4.00 | 0.94 | -0.44 | -0.29 | 1 | 5 |
| T3 | F-T-F learning | 3.55 | 4.00 | 0.92 | -0.83 | 0.23 | 1 | 5 |
|    | Online learning | 3.38 | 4.00 | 1.03 | 0.50 | -0.54 | 1 | 5 |
|    | Blended learning | 3.65 | 4.00 | 1.05 | -1.01 | 0.50 | 1 | 5 |

$N = 193$. Natural mid-point $= 3$

single-factor solution was developed to determine the above two factors (Table 3). The natural mid-point was the middle point across the items of each factor.

### 4.2 The participants' intention to undertake different learning modes from T1 to T3

#### 4.2.1 Descriptive results of the participants' intention to learn in different modes

Table 4 shows the number of participants intending to undertake online, blended, and F-T-F learning from T1 to T3. The means of the participants' intention of undertaking the three learning modes were higher than the natural mid-point of 3 (Table 5).

#### 4.2.2 Testing the changes in the participants' intention to learn in different modes from T1 to T3

The researchers performed Friedman Test to examine the changes in the participants' behavioral intention to learn respectively in online, blended, and F-T-F modes from T1 to T3, followed by the Wilcoxon Signed-Rank Test for paired comparison. The analysis of the Friedman Test showed that the participants' intention to learn online significantly changed from T1 to T3 ($\chi^2(2) = 34.64$, $p < 0.001$). Compared with blended and F-T-F learning, the participants' intention of online learning fluctuated throughout COVID from the lowest level at T1 to a higher level at T2 and then slightly dropped at T3 (Table 6, Appendix 1).

Then Wilcoxon Signed-Rank Test with Bonferroni correction was used to compare the participants' intention to learn online between two-time points (i.e., T1 and T2, T2 and T3, and T1 and T3). Compared with T1, the participants' intention to learn online significantly increased at T2 ($Z = -4.56$, $p < 0.001$). By T3, the participants' intention to learn online showed a slight drop, but the change was

not significant. Their online learning intention at T3 was still significantly higher than that at T1 ($Z = -4.22$, $p < 0.001$).

The researchers found significant changes in the participants' intention to learn in an F-T-F mode from T1 to T3 ($\chi^2(2) = 38.63$, $p < 0.001$). Compared with T1, the participants became less willing to learn in an F-T-F mode at T2 ($Z = -6.17$, $p < 0.001$). Then their intention to learn in a F-T-F mode significantly increased from T2 to T3 ($Z = -4.99$, $p < 0.001$).

Regarding the participants' intention to learn in a blended mode from T1 to T3, their intention significantly changed through T1, T2 to T3 ($\chi^2(2) = 8.26$, $p < 0.05$). The participants' blended learning intention significantly decrease from T1 to T2 ($Z = -2.54$, $p < 0.05$) and then increased from T2 to T3 ($Z = -2.87$, $p < 0.05$).

### 4.2.3 Comparing the participants' intention to learn in different modes at each time point

The results of the Friedman Test showed significant differences in the participants' intention to learn in different modes (i.e., F-T-F, online, and blended modes), respectively, at T1, T2, and T3 (Table 6, Appendix 1). The Wilcoxon Signed-Rank Test with Bonferroni correction showed that, at T1, the participants showed a higher level of behavioral intention to take F-T-F learning ($Z = -6.49$, $p < 0.001$) and blended learning ($Z = -5.80$, $p < 0.001$) than online learning. At T2, the participants' intention to learn in a blended context ($Z = -3.17$, $p < 0.01$) was significantly higher than their F-T-F learning intention. Although their online learning intention increased to a higher level than F-T-T learning intention at T2, such difference was not significant ($Z = -2.12$, $p = 0.09$). At T3, blended learning was rated with the highest level of behavioral intention among the participants. Their intention to learn online dropped to a significantly lower level than in blended learning ($Z = -2.62$, $p < 0.05$).

**Table 6** Friedman test of the participants' intention of different learning modes at T1, T2, and T3

| Time point | Behavioral intention | Mean ranks | $\chi^2(2)$ | Sig | $df$ |
|---|---|---|---|---|---|
| T1 | F-T-F learning | 2.18 | | | |
| | Online learning | 1.65 | 53.99 | $p < 0.001$ | 2 |
| | Blended learning | 2.17 | | | |
| T2 | F-T-F learning | 1.84 | | | |
| | Online learning | 2.08 | 10.40 | $p < 0.01$ | 2 |
| | Blended learning | 2.09 | | | |
| T3 | F-T-F learning | 1.98 | | | |
| | Online learning | 1.86 | 14.16 | $p < 0.01$ | 2 |
| | Blended learning | 2.16 | | | |

$N = 193$

**Table 7** Frequencies of learning capability, application of online learning strategies, online course engagement, and academic performance

| Factor | Time point | Mean | Median | SD | Skewness | Kurtosis | Minimum | Maximum | Natural mid-point |
|---|---|---|---|---|---|---|---|---|---|
| General learning capability | T1 | 2.15 | 2.00 | 0.47 | 0.19 | -0.31 | 1 | 3 | |
| | T2 | 1.75 | 1.67 | 0.52 | 0.42 | -0.33 | 1 | 3 | 2 |
| | T3 | 2.15 | 2.00 | 0.45 | -0.01 | 0.01 | 1 | 3 | |
| Application of online learning strategies | T1 | 3.45 | 3.5 | 0.64 | 0.26 | 0.08 | 2 | 5 | |
| | T2 | 3.76 | 3.75 | 0.60 | -0.19 | 0.39 | 2 | 5 | 3 |
| | T3 | 3.82 | 3.88 | 0.57 | -0.07 | 0.02 | 2.25 | 5 | |
| Online course engagement | T1 | 2.10 | 2.00 | 0.57 | 0.02 | 0.40 | 1 | 3 | |
| | T2 | 1.70 | 2.00 | 0.64 | 0.35 | -0.68 | 1 | 3 | 2 |
| | T3 | 2.05 | 2.00 | 0.58 | -0.001 | 0.00 | 1 | 3 | |
| Academic performance | T1 | 3.24 | 3.00 | 0.93 | -0.07 | -0.32 | 1 | 5 | |
| | T2 | 3.17 | 3.00 | 0.96 | 0.004 | -0.22 | 1 | 5 | 3 |
| | T3 | 3.16 | 3.00 | 0.89 | -0.04 | 0.10 | 1 | 5 | |

$N = 193$

### 4.3 The participants' learning capability, application of online learning strategies, academic performance, and online course engagement from T1 to T3

Table 7 depicts the levels of the participants' learning capability in general, application of online learning strategies, online learning engagement, and academic performance from T1 to T3. The participants' learning capability was at the lowest level at T2, significantly lower than T1 and T3 ($\chi^2(2) = 97.01$, $p < 0.001$). On the other hand, the participants' application of online learning strategies increased from T1 to T3. Their application of online learning strategies at T2 and T3 was significantly higher than T1 ($\chi^2(2) = 102.57$, $p < 0.001$). Furthermore, compared with T1 and T3, the participants' online course engagement was at the lowest level at T2 ($\chi^2(2) = 62.58$, $p < 0.001$). Finally, despite a decrease in the participants' academic performance from T1 to T3, this change was not significant.

### 4.4 Influential factors on the participants' behavioral intention to learn online

Pearson test indicated that the participants' intention to learn online at T3 was significantly correlated with their online learning intention at T1 and T2 and application of online learning strategies and online course engagement at T2, which was related to the other factors of blended and F-T-F learning intention, learning capability in general, application of online learning strategies, online course engagement, and academic performance at T1, T2, or T3 (Appendix 2). PLS-SEM was then performed to test the relationships between the participants' learning capability in general, application of online learning strategies, online course engagement, and academic performance, and online learning intention after the COVID lockdown. Bootstrapping in PLS-SEM is a nonparametric procedure that is less subject to violation of the normality assumption and allows testing the statistical significance of various PLS-SEM results such as path coefficients (Davison & Hinkley, 1997; Efron & Tibshirani, 1994; Unal & Uzun, 2021).

PLS-SEM displayed significant pathways of the relationships (i.e., inner model path coefficient sizes) between the participants' behavioral intention to undertake different learning modes, general learning capability, application of online learning strategies, and online course engagement at T1, T2, and T3 (Fig. 1). Overall, the participants' intention to undertake different learning modes, general learning capability, and application of online learning strategies at T1 and T2, respectively, significantly influenced the corresponding individual factor at T3. The participants' general learning capability could predict their application of online learning strategies and online course engagement, which in turn influenced their intention to learn in an online or blended mode.

Regarding the participants' intention to learn in different modes at T3, the researchers found that the participants' online learning intention at T3 was directly affected by a) their online learning intention at T1 and T2, and b) online course engagement at T2 ($R^2 = 0.37$, $p < 0.05$). Additionally, the other factors exerting indirect influences on the participants' online learning intention at T3 included a) general learning capability and application of online learning strategies at T1 and T2, b) online learning intention and online course engagement at T1, and c) F-T-F learning intention at T2. It was
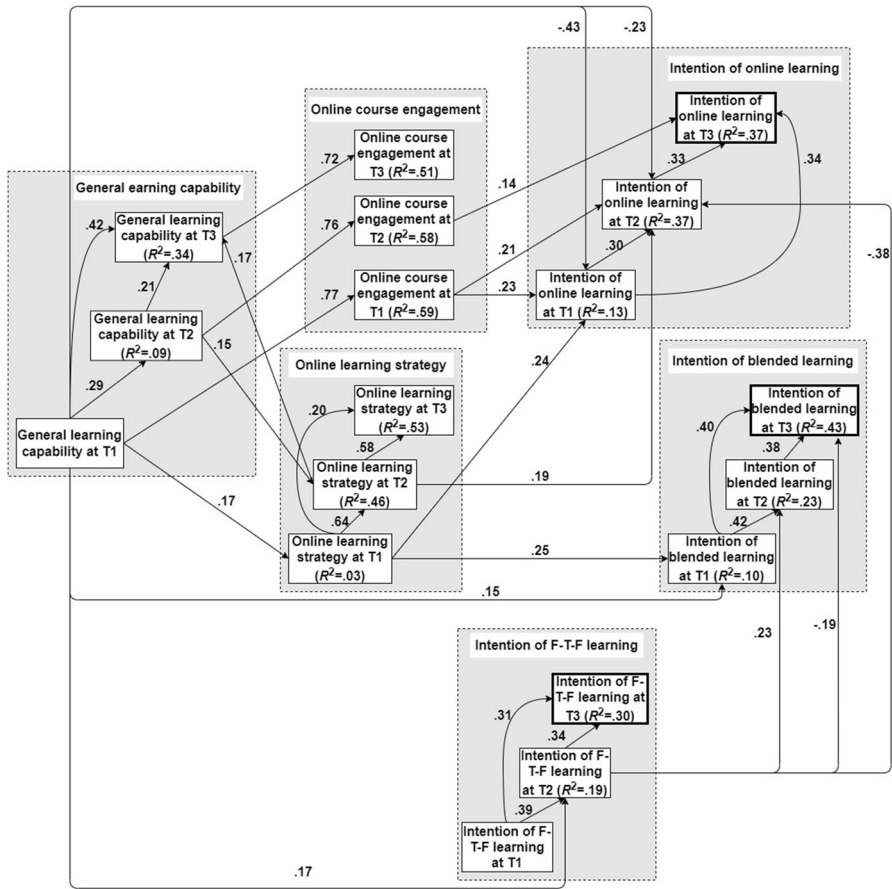
**Fig. 1** Model of the participants' behavioral intention to undertake F-T-T, blended, and online learning from T1 to T3

noted that the participants' general learning capability at T1 negatively predicted their intention of online learning at T1 and T2. The participants' intention of F-T-F learning at T2 negatively influenced their intention of online learning at T2.

Concerning the participants' blended learning intention, besides the direct impact from blended learning intention at T2, their learning capability at T1 indirectly predicted their blended learning intention at T3. This relationship was mediated by the participants' online learning strategy application at T1, blended learning intention at T1 and T2, and F-T-F learning intention at T2 ($R^2 = 0.43$, $p < 0.05$). The participants' willingness to undertake F-T-F learning at T2 had a positive impact on their blended learning intention at T2, but negatively influenced their blended learning intention at T3. Finally, the participants' F-T-F learning intention at T3 was directly affected by their F-T-F learning intention at T1 and T2 and indirectly influenced by their general learning capability at T1 ($R^2 = 0.30$, $p < 0.05$).

**Table 8** Summary of the changes in the participants' behavioral intention to learn online from T2 to T3

| IG | | | | DG | | | | NCG | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| N | T2 | → | T3 | N | T2 | → | T3 | N | T2 | → | T3 |
| 14 | Negative | → | Positive | 11 | Positive | → | Negative | 70 | Remain positive | | |
| 9 | Unsure | → | Positive | 11 | Unsure | → | Negative | 14 | Remain unsure | | |
| 4 | Positive | → | More positive | 3 | Negative | → | More negative | 18 | Remain negative | | |
| 9 | Negative | → | Less negative | 30 | Positive | → | Less positive | | | | |
| Totality | 36 | | | | 55 | | | | 102 | | |

## 4.5 The participants' responses to the open-ended questions

### 4.5.1 Grouping the participants according to the changes in their online learning intention

In order to further interpret the changes in the participants' intention to learn online from T2 to T3, the researchers assigned the participants, who displayed increases, decreases, and no change in their online learning intention, respectively, into the Increase Group (IG), Decrease Group (DG), and No-Change Group (NCG). Table 8 shows that, compared with their online learning intention at T2, 102 participants didn't reveal any change in their intention at T3. Hence, these participants were assigned to NCG. Then, the other 55 and 36 participants, respectively, showed more or fewer decreases and increases in their online learning intention from T2 to T3. Therefore, the former group was labelled as DG, and the latter was categorized as IG.

More IG (25%) and NCG members (66%) intended to learn in an online learning environment than the DG members (9%), $X^2$ (4, $n = 193$) = 45.98, $p < 0.01$ (Table 9). Fisher's Exact Test was performed due to a situation where the frequency of one cell is less than five (Armitage & Berry, 2002). The finding from Fisher's Exact Test supported the significant differences in the three groups' behavioral intention to learn online at T3 ($p < 0.01$, FET).

### 4.5.2 The IG, NCG, and DG participants' responses to the open-ended questions

One hundred and forty-six participants provided comments indicating how they perceived online learning during COVID. Sixty-nine participants responded to the question about their expectations of future online courses. The main themes were generated from the three groups of participants' statements and presented by the number of instances (Tables 10 and 11).

The participants' perceptions of online learning were interpreted with four indicators (i.e., affective judgement, advantages, potential issues, and negative prior experience) (Table 10). Regarding affective judgement, the participants' responses revealed their positive or negative feelings about and judgement on online learning (Appendix 3). A significant negative correlation was found between the changes in the participants' online learning intentions from T2 to T3 and the instances of their negative comments. The more increases displayed

**Table 9** The IG, NG, and NCG members' intention to learn online at T3

|  | Disagree to learn online | Unsure | Agree to learn online |
|---|---|---|---|
| Increase Group | 2 (4%) | 7 (17%) | 27 (25%) |
| No Change Group | 18 (40%) | 14 (34%) | 70 (66%) |
| Decrease Group | 25 (56%) | 20 (49%) | 10 (9%) |
| Total | 45 (100%) | 41 (100%) | 107 (100%) |

$N = 193$

**Table 10** Instances of the participants' perceptions of online learning during COVID lockdown

| Themes generated from the participants' comments | | | Instances cited by the three groups of participants | | | | | | The totality of instances across three groups |
|---|---|---|---|---|---|---|---|---|---|
| | | | IG | % | NCG | % | DG | % | |
| Perception and comments | Affective judgement | Positive | 4 | 33.3% | 7 | 58.3% | 1 | 8.3% | 12 |
| | | Negative | 2 | 1% | 7 | 35% | 11 | 55% | 20 |
| | Advantages | | 4 | 13% | 12 | 39% | 15 | 48% | 31 |
| | Potential issues | | 13 | 26% | 22 | 44% | 15 | 30% | 50 |
| | Negative prior experience | | - | - | - | - | 1 | 100% | 1 |
| The totality of instances in each group | | | 23 | | 48 | | 43 | | 114 |

Instances = frequency of the themes generated from the participants' statements; % presents the proportion of the value in each cell in the totality of instance of each theme across three groups

**Table 11** Instances of the participants' expectations of future online courses

| Themes generated from the participants' comments | | Instances cited by the three groups of participants | | | | | | The totality of instances across three groups |
|---|---|---|---|---|---|---|---|---|
| | | IG | % | NCG | % | DG | % | |
| Expectations | Improving learner capability | 4 | 8% | 17 | 11% | 2 | 3.3% | 23 |
| | Human factors | 17 | 35% | 46 | 30% | 20 | 33.3% | 83 |
| | Instructional design and approaches | 18 | 38% | 54 | 36% | 21 | 35% | 93 |
| | Course management | 6 | 13% | 22 | 14% | 11 | 18.3% | 39 |
| | Course interface and technical environment | 3 | 6% | 12 | 8% | 6 | 10% | 21 |
| | Course choice | - | - | 1 | 1% | - | - | 1 |
| The totality of instances in each group | | 48 | | 152 | | 60 | | 260 |

Instances = frequency of the themes generated from the participants' statements; % presents the proportion of the value in each cell in the totality of instance in each group

by the participants in their online learning intention, the less negative affective judgements they made about online learning during COVID ($r = -0.998$, $p < 0.05$).

The IG, NCG, and DG members made positive affective judgements about online learning, such as "online learning is good", "I am satisfied with online learning", "I prefer online learning", and so on. The participants' negative feelings about online learning focused on their dislike of online learning, unwillingness to take online courses, like of F-T-F learning, and difficulty adapting to online learning. Besides, DG members made more negative comments on online learning than those in IG and NCG (Appendix 3). The participants' perception of online learning implied how their views of online learning gradually changed throughout COVID (Appendix 5).

Furthermore, the IG, NCG, and DG members made judgments about the advantages of online learning, such as convenience, flexibility, easiness of reviewing course content, and supporting learning with technologies and enriched resources. NCG and DG members also mentioned that online learning supported self-regulated or self-paced learning and enriched learning resources. Being forced to shift online, the participants became more familiar with using online learning resources and tools for learning (Appendix 6).

On the other hand, the three groups of members reported a number of potential issues with online learning. The participants' comments implied how they weighed the strengths and weaknesses of different learning modes when completing online courses during COVID. First, the participants expressed concern about a lack of self-control and self-regulation and the heavy workload during online learning. Moreover, NCG and DG members reported the issues, such as a) boring online learning experiences, b) a low level of learning efficiency and achievement, c) unclear course information and a lack of updates and authority of course information, and d) a low level of learning motivation. Finally, the IG and DG members claimed a lack of F-T-F teacher-student and peer interaction and physical issues during online learning (Appendix 7).

The participants' expectations of future online courses were categorized as learner capability, human factors, instructional design and approaches, course management, and course interface and technical environment (Table 11, Appendix 4). The participants' expectations of learner capability focused on the improvement of self-control and self-regulation in learning and ICT competence. In regards to human factors, the participants expected more interactions with their teachers and peers with emotional support, but also an improvement in the immediacy and quality of online interactions. Concerning instructional design and approaches, the participants expected future online courses to attract and engage students, provide quality learning resources, and improve assessment design. Regarding course management, the participants requested strong supervision and monitoring from teachers and a clearer schedule of online courses. Some DG members reported that they encountered other issues, such as unprepared course transition and insufficient or delayed responses from their teachers and peers. This hindered their online learning even though they rated themselves as high-achievers in normal courses (Appendix 8).

Additionally, NCG members claimed that students' feedback should be valued for course quality control, and teaching staff should receive more support. The

expectations of course interface and technical environment include clearer presentation of course websites, stable Internet connection, comprehensive functions of course management systems, and the consistency of course platforms across different university programs. Finally, the NCG members expressed a need for expert recommendations on their online course choices.

# 5 Discussion

## 5.1 The participants' learning capability, application of online learning strategies, and online course engagement

The researchers identified a decrease reported by the participants in the factors of general learning capability and online course engagement but an increase in their application of specific online learning strategies during COVID. In the present study, learning capability focused on the students' control of their concentration, effort, creative skills, persistence, and effective execution of learning strategies in general. However, the application of online strategies indicated how well the students applied particular approaches suitable for online learning, such as online searching, information management, and online communication and collaboration.

Online courses during COVID physically isolated the participants from their teachers and peers, set a high requirement for their self-control and self-adaptation, and needed greater discipline and commitment to learning (Muthuprasad et al., 2020). The participants' statements revealed that online learning during the COVID lockdown challenged their self-control in learning, especially concentration and management in their study. Even though some participants had more opportunities to practice various online learning tools during COVID, they felt their learning was inefficient, and their course engagement was at a low level. Twenty-three per cent of the participants responded that they did not have a high level of self-control while learning online during COVID, especially when the online courses were not well-prepared. The online courses without good preparation, quality design, and strong supervision may be rather challenging for students, even those who considered themselves to be high achievers in F-T-F courses (Please see the comments from Participants No. 10, 21, and 40).

In respect of the participants' application of online learning strategies, online courses during COVID in the present study forced them to use technology in learning. In this sense, shifting all courses online during COVID exposed the participants to a high level of ICT usage, which might help to improve their digital competencies in their learning (Billings et al., 2001; Kenny, 2002). With frequent access to an array of online learning resources and tools, the participants improved their specific skills of using online resources and tools to complete online learning tasks (Please see the comments from Participants No. 5 and 122).

### 5.2　The participants' behavioral intention to learn online throughout COVID

The participants' online learning intention showed a fluctuation from the lowest level at T1 to the highest level at T2, followed by a slight drop back to a lower level than blended and F-T-F learning at T3. Learners' intention to take certain learning modes may vary over time and across different courses under unstable conditions (Unal & Uzun, 2021). The COVID resulted in school closedown and a transfer of education from F-T-F to online teaching. For some students, shifting to online learning may not be their subjective tendency. However, during a public crisis such as the COVID pandemic, online courses would be the only available option for students to receive an education.

In the university in the present research, some courses have been taught through a blended mode on well-developed course platforms for many years. Therefore, when the university was closed down, these blended courses could be transferred to online courses smoothly. However, the other courses, previously taught through F-T-F instruction, may not satisfy students' learning needs and meet the standards as quality online courses due to insufficient preparation, teachers' low digital competencies, a lack of support for teaching staff, etc. When students learned online under tremendous pressure relative to uncertainty in crisis situations, academic performance, and absence of interpersonal communication during COVID, the course with quality design and management and vital learning and emotional support would help to ease their anxiety in the courses and thus increase their intention to learn online (Cao et al., 2020). On the contrary, an online course without a good instructional design and sufficient support may negatively impact students' behavioral intention to continue online learning (e.g., Participants No. 6 and 12).

Concerning students' intention to learn in different contexts during the COVID lockdown, the participants' intention to learn in a blended learning context was at a higher level than that in a classroom. After COVID, the participants remained a higher level of behavioral intention to learn in a blended mode than an online or F-T-F learning mode. Their likeliness to learn online during COVID continued to impact their intention of online learning after COVID. The participants' statements about their perception of online learning provided underlying reasons for their behavioral intention after COVID. Their comments about online learning revealed that they compared F-T-F, online, and blended learning environments when choosing a future learning mode. The more they preferred F-T-F learning components, the more unlikely they were to undertake online learning in future. The participants with the decreased behavioral intention to learn online after COVID provided more comments depicting negative feelings (e.g., Participant No. 40).

Classroom teaching has a long history for human beings to transfer knowledge, experiences, and cultivation. Students' online learning experiences during COVID may provoke them to deliberate on the strengths and limitations of each learning mode and make a decision for their future learning (Gonzalez-Ramirez et al., 2021). Despite commonly accepted advantages of online learning, such as flexibility, convenience, and rich course resources (Petrides, 2002; Poole, 2000), students are still concerned about the issues of lacking human contact, unfunctional course interface, insufficient and boring course information and materials, and harm to physical

health (Gonzalez-Ramirez et al., 2021; Luan et al., 2020; Muthuprasad et al., 2020). Adedoyin and Soykan (2020) and Azubuike et al. (2021) compared online with F-T-F learning modes and assumed that blended learning could combine the advantages of the above learning modes. Almuraqab (2020) also found that half of the students (49%) in his research favored blended learning and suggested that policymakers should develop guidelines for universities to continue offering a blended learning system. Blended learning may be the focus and mainstream course delivery in the post-COVID era, as it combines the advantages of human contact and technologies supporting online learning (Saboowala & Mishra, 2021).

It was noted that the participants, who reported a higher level of learning capability before COVID, were less likely to learn online during COVID. This finding was inconsistent with some existing research. For example, Alhamami (2018) found that students' intention to learn a foreign language online could be determined by their abilities to perform in the course. Hood (2013) concluded that students' thinking skills (e.g., critical thinking), commitment to work, and ability to regulate their learning significantly predict their intention to use online lectures. The particular context of ERT during COVID was different from normal online teaching. The participants in the present study differed considerably in their learning needs and preferences. Take the statements from Participants No. 38, 50, and 92 as examples. These students believed themselves to be high achievers in their university courses but encountered the issues of poor quality of online course design and a lack of timely support from teachers and peers. The participants recalled that online learning set a much higher requirement on learners' overall ability to manage themselves well to complete learning tasks. They still preferred learning through F-T-F instruction, as they believed that they could make the best use of their learning skills in an F-T-F learning context.

The above participants' comments on their learning experiences were consistent with the research by Schultz and DeMers (2020), who believed that emergent transfer to online course delivery without good preparation would hinder students' active online learning. When struggling to juggle between multiple online learning tasks in different courses without sufficient and timely support, students may hardly build their confidence to take more online courses in future. Even high achievers may reconsider their own capability of adapting to online courses and choose a course delivery that would guarantee a smooth course experience and maximize their strengths. Moreover, the mediation of online learning strategies and course engagement on the relationship between general learning capability and behavioral intention of online learning implied that the participants with a high level of learning capability exerted effective online learning strategies, kept a high level of course input, and intended to continue to undertake more online courses. Nevertheless, students' online course input and active application of learning strategies need to be supported by sound pedagogical design and strong learning and emotional support from teaching staff. In the post-COVID era, when blended teaching is becoming the mainstream of course delivery, effective pedagogical design should be explored to boost students' motivation to use effective learning strategies to balance their own F-T-F and online learning and maintain a high level of course engagement both online and offline.

Regarding the participants' expectations of future online courses, "instructional design and approaches" and "human factors" showed a higher proportion than the other

themes. As seen from the example comments provided by the participants, besides students' learning capability, online course design and teachers' competency to deliver instruction and sufficient and effective support are critical to ensure students' positive learning experiences and satisfactory course outcomes. During ERT, it would be necessary to provide students with notice regarding the challenges of online learning and possible consequent decrease in learning efficiency and course performance as a result of insufficient preparation and a lack of self-discipline, motivation, and effective application of learning strategies (Aristovnik et al., 2020; Golladay et al., 2000).Therefore, it is essential to integrate specific student training into daily teaching to improve students' motivation, self-regulatory learning skills, and self-management of learning, which will benefit students to be well-prepared for regular and emergent online teaching situations (e.g., Aristovnik et al., 2020; Muthuprasad et al., 2020). Moreover, supportive online communication and meaningful course activities will help to keep students focused on their learning (Hara & Kling, 1999; Muthuprasad et al., 2020; Vonderwell, 2003).

It is noted that the participants expected that online courses could provide attracting and engaging learning materials and activities. Unlike classroom teaching, online courses lack physical contact between teachers and students. Even though university students, regarded as adult learners, are capable of accomplishing complex cognitive activities and enduring boring learning tasks for long periods, they still need engaging course design with fun factors to keep themselves actively participating in online course activities. Furthermore, consistency in course design and learning objectives, a clear course structure with engaging and interactive learning resources, quality instruction, and strong learning support will ensure that students effectively follow teachers' guidance and better understand the course content (Sun & Chen, 2016).

Finally, the participants claimed that they needed user-friendly learning platforms with useful functions supporting personalized learning. The participants' expectations of online course platforms focused on the clarity and standardization of course interface, improved functions and easiness to use course platforms, and integration of new technology into the platforms. Yan et al. (2021) emphasized the importance of a sound technical environment supporting students' online learning. The technical issues during online learning, such as poor Internet connection, technology infrastructure, and malfunctions of course interface, could negatively influence students' online learning experiences and attitudes. Such issues may even set the most influential barrier to successful delivery of online courses in developing countries when neither the teachers nor the students were prepared for the transition to online learning during regular times or an emergent public crisis (Blizak et al., 2020).

## 6 Limitation

The present study was conducted in a Chinese university located in Zhejiang. Therefore, the findings may not be suitable to generalize to other countries under more severe attacks of COVID. Further studies on students' online learning intention can be extended to the regions with different policies of the blockade or under different levels of impact of COVID.

The aim of the research was to observe the changes in university students' intention to learn in F-T-F, online, and blended modes throughout COVID. The researchers attempted to capture the students' willingness to learn in the three modes before, during, and after COVID. Due to the rapid disruption of COVID, the university was shut down unexpectedly in March 2020. During the COVID, the researchers had limited samples for data collection because a very small sample of students could be contacted. Therefore, the researchers conducted the questionnaire survey after the university was reopened in September 2020. By doing this, a reasonable sample of students could be guaranteed. Future research on the variation of university students' behavioral intention of online learning can target a considerable population of students with continuous observation of their views of online learning at different stages.

Furthermore, according to the project's ethics requirements, the questionnaire survey was completed by the participants anonymously, and the researchers could not identify the anonymous responses from the participants with their actual GPAs. There is a need for further research with the consideration of using an automated mechanism of capturing the actual data relevant to students' learning process and results to gain a complete picture of the relationships between university students' capability, strategies, engagement, progress, and achievement in an online or blended course.

## 7 Conclusion

The present paper identified significant changes in a group of Chinese university students' behavioral intention to learn in an online environment compared with blended and F-T-F learning contexts throughout COVID. The students' intention of certain learning modes can continue to impact their future preferences. Moreover, the students' learning capability, application of online learning strategies, online course engagement either directly or indirectly influenced their behavioral intention of different learning modes. Undertaking several courses during ERT may set a great challenge for students. Especially, the courses without a good pedagogical design and sufficient learning and emotional support may hinder students' active course participation. Online teaching is a technical issue and a pedagogical and instructional challenge no matter during normal teaching or public crises (Ali, 2020). Hence, when designing and delivering online courses, teachers need to keep focusing on meaningful learning activities to fully engage their students and attend to their needs with strong support and course management.

Additionally, the composition of online learners is diversifying in their learning capability and preference. The students, who choose to learn online, may value particular advantages of online teaching that can well suit their individual needs. Online educators should notice the differences among their students in terms of learning capability, needs, and preferences to provide more personalized instruction and support.

Nevertheless, it can be challenging for teachers to implement online course delivery and management during ERT when few are well-prepared for a sudden transition to online teaching. Given that we live in a volatile environment where on-campus education may be interrupted by a number of factors (such as what we experienced

with the COVID lockdown), even in many countries and areas where F-T-F instruction has been resumed, teachers still ought to consider their teaching practice in online and blended modes based on the lessons being learned so far. It is important for researchers and educators to deliberate what teachers and students need to do for upcoming interruptions to avoid repeating our mistakes, such as overlooking interactivity during online teaching, a lack of quality design on course structure and content, and insufficient online learning and emotional support (Aguilera-Hermida, 2020; Bozkurt & Sharma, 2020; Hussein et al., 2020). Teachers and students ought to realize the trend of blended learning and adapt themselves to a normalized combination of F-T-F and online instruction in the post-COVID era.

**Data availability** The data in the present study cannot be publicly available to preserve individuals' privacy according to the confidentiality and privacy requirements of the ethics committee in the university where the study was conducted.

## Declarations

**Competing interests** We have no conflict of financial or non-financial interest that are directly or indirectly related to the work submitted for publication.

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