The state of E-learning in higher education in the era of the pandemic: How do we move forward?

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The state of E-learning in higher education in the era of the pandemic: How do we move forward?

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Distance Learning in Higher Education During Covid-19

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COVID-19's pandemic has hastened the expansion of online learning across all levels of education. Countries have pushed to expand their use of distant education and make it mandatory in view of the danger of being unable to resume face-to-face education. The most frequently reported disadvantages are technological challenges and the resulting inability to open the system. Prior to the pandemic, interest in distance learning was burgeoning, as it was a unique style of instruction. The mini-review aims to ascertain students' attitudes about distant learning during COVID-19. To accomplish the objective, articles were retrieved from the ERIC database. We utilize the search phrases "Distance learning" AND "University" AND "COVID." We compiled a list of 139 articles. We chose papers with "full text" and "peer reviewed only" sections. Following the exclusion, 58 articles persisted. Then, using content analysis, publications relating to students' perspectives on distance learning were identified. There were 27 articles in the final list. Students' perspectives on distant education are classified into four categories: perception and attitudes, advantages of distance learning, disadvantages of distance learning, and challenges for distance learning. In all studies, due of pandemic constraints, online data gathering methods were selected. Surveys and questionnaires were utilized as data collection tools. When students are asked to compare face-to-face and online learning techniques, they assert that online learning has the potential to compensate for any limitations caused by pandemic conditions. Students' perspectives and degrees of satisfaction range widely, from good to negative. Distance learning is advantageous since it allows for learning at any time and from any location. Distance education benefits both accomplishment and learning. Staying at home is safer and less stressful for students during pandemics. Distance education contributes to a variety of physical and psychological health concerns, including fear, anxiety, stress, and attention problems. Many schools lack enough infrastructure as a result of the pandemic's rapid transition to online schooling. Future researchers can study what kind of online education methods could be used to eliminate student concerns.

Keywords: ICT, distance learning, COVID-19, higher education, online learning

INTRODUCTION

The pandemic of COVID-19 has accelerated the spread of online learning at all stages of education, from kindergarten to higher education. Prior to the epidemic, several colleges offered online education. However, as a result of the epidemic, several governments discontinued face-to-face schooling in favor of compulsory distance education.

The COVID-19 problem had a detrimental effect on the world's educational system. As a result, educational institutions around the world developed a new technique for delivering instructional programs (Graham et al., 2020; Akhmadieva et al., 2021; Gaba et al., 2021; Insorio and Macandog, 2022; Tal et al., 2022). Distance education has been the sole choice in the majority of countries throughout this period, and these countries have sought to increase their use of distance education and make it mandatory in light of the risk of not being able to restart face-to-face schooling (Falode et al., 2020; Gonçalves et al., 2020; Tugun et al., 2020; Altun et al., 2021; Valeeva and Kalimullin, 2021; Zagkos et al., 2022).

What Is Distance Learning

Britannica defines distance learning as "form of education in which the main elements include physical separation of teachers and students during instruction and the use of various technologies to facilitate student-teacher and student-student communication" (Simonson and Berg, 2016). The subject of distant learning has been studied extensively in the fields of pedagogics and psychology for quite some time (Palatovska et al., 2021).

The primary distinction is that early in the history of distant education, the majority of interactions between professors and students were asynchronous. With the advent of the Internet, synchronous work prospects expanded to include anything from chat rooms to videoconferencing services. Additionally, asynchronous material exchange was substantially relocated to digital settings and communication channels (Virtič et al., 2021).

Distance learning is a fundamentally different way to communication as well as a different learning framework. An instructor may not meet with pupils in live broadcasts at all in distance learning, but merely follow them in a chat if required (Bozkurt and Sharma, 2020). Audio podcasts, films, numerous simulators, and online quizzes are just a few of the technological tools available for distance learning. The major aspect of distance learning, on the other hand, is the detailed tracking of a student's performance, which helps to develop his or her own trajectory. While online learning attempts to replicate classroom learning methods, distant learning employs a computer game format, with new levels available only after the previous ones have been completed (Bakhov et al., 2021).

In recent years, increased attention has been placed on eLearning in educational institutions because to the numerous benefits that have been discovered via study. These advantages include the absence of physical and temporal limits, the ease of accessing material and scheduling flexibility, as well as the cost-effectiveness of the solution. A number of other studies have demonstrated that eLearning is beneficial to both student gains and student performance. However, in order to achieve the optimum results from eLearning, students must be actively participating in the learning process — a notion that is commonly referred to as active learning — throughout the whole process (Aldossary, 2021; Altun et al., 2021).

The most commonly mentioned negatives include technological difficulties and the inability to open the system as a result, low teaching quality, inability to teach applicable disciplines, and a lack of courses, contact, communication, and internet (Altun et al., 2021). Also, misuse of technology, adaptation of successful technology-based training to effective teaching methods, and bad practices in managing the assessment and evaluation process of learning are all downsides of distance learning (Debeş, 2021).

Distance Learning in a Pandemic Context

The epidemic forced schools, colleges, and institutions throughout the world to close their doors so that students might practice social isolation (Toquero, 2020). Prior to the pandemic, demand for distance learning was nascent, as it was a novel mode of education, the benefits and quality of which were difficult to judge due to a dearth of statistics. But, in 2020, humanity faced a coronavirus pandemic, which accelerated the shift to distant learning to the point that it became the only viable mode of education and communication (Viktoria and Aida, 2020). Due to the advancements in digital technology, educators and lecturers have been obliged to use E-learning platforms (Benadla and Hadji, 2021).

In remote education settings for higher education, activities are often divided into synchronous course sessions and asynchronous activities and tasks. In synchronous courses, learners participate in interactive and targeted experiences that help them develop a fundamental grasp of technology-enhanced education, course design, and successful online instruction. Asynchronous activities and tasks, on the other hand, include tests, group work assignments, group discussion, feedback, and projects. Additionally, asynchronous activities and tasks are carried out via interactive video-based activities, facilitator meetings, live webinars, and keynote speakers (Debeş, 2021).

According to Lamanauskas and Makarskaitė-Petkevičienė (2021), ICT should be attractive for learners. Additionally, student satisfaction with ODL has a statistically significant effect on their future choices for online learning (Virtič et al., 2021). According to Avsheniuk et al. (2021), the majority of research is undertaken to categorize students' views and attitudes about online learning, and studies examining students' perspectives of online learning during the COVID-19 epidemic are uncommon and few. There is presently a dearth of research on the impact on students when schools are forced to close abruptly and indefinitely and transition to online learning communities (Unger and Meiran, 2020). So that, the mini-review is aimed to examining the students' views on using distance learning during COVID-19.

TABLE 1 | Countries and data collection tools.

Author(s)	Countries	Data collection tools
Abrosimova, 2020	Russia	Questionnaire
Adnan and Anwar, 2020	Pakistan	Survey
Akcil and Bastas, 2021	Cyprus	Attitudes Scale
Aldossary, 2021	Saudi Arabia	Questionnaire
Altun et al., 2021	Turkey	Evaluation form
Avsheniuk et al., 2021	Ukraine	Questionnaire
Bakhov et al., 2021	Ukraine	Survey
Beltekin and Kuyulu, 2020	Turkey	Survey
Benadla and Hadji, 2021	Algeria	Questionnaire
Bozavlı, 2021	Turkey	Questionnaire
Didenko et al., 2021	Ukraine	Questionnaire
Glebov et al., 2021	Russia	Survey
Gonçalves et al., 2020	Portugal	Survey
Kaisar and Chowdhury, 2020	Bangladesh	Survey
Lamanauskas and Makarskaitė-Petkevičienė, 2021	Lithuania	Open questions
Lassoued et al., 2020	Algerian, Egyptian, Palestinian, Iraqi	Questionnaire
Lin and Gao, 2020	China	Survey
Martha et al., 2021	Indonesia	Questionnaire
Mathew and Chung, 2020	Malaysia	Questionnaire
Nenakhova, 2021	Russia	Questionnaire, interview
Önöral and Kurtulmus-Yilmaz, 2020	Cyprus	Yes-No questions
Şahin, 2021	Turkey	Interview
Taşkaya, 2021	Turkey	Questionnaire
Todri et al., 2021	Albanians, Italians, Moroccans, Algerians North African	Survey
Unger and Meiran, 2020	United States	Survey
Viktoria and Aida, 2020	Japanese, Russian	Survey
Yurdal et al., 2021	Turkey	Survey

In order to perform the aim, the articles were searched through ERIC database. We use "Distance learning" AND "University" AND "COVID" as search terms. We obtained 139 articles. We selected "full text" and "Peer reviewed only" articles. After the exclusion, 58 articles endured. Then content analyses were used to determine articles related to students' voices about distance learning. In the final list, there were 27 articles (**Table 1**).

In the study, a qualitative approach and content analyses were preferred. Firstly, the findings related to students' attitudes and opinions on distance learning were determined. The research team read selected sections independently. Researchers have come to a consensus on the themes of perception and attitudes, advantages of distance learning, disadvantages of distance learning, and challenges for distance learning. It was decided which study would be included in which theme/s. Finally, the findings were synthesized under themes.

Only 3 studies (Lassoued et al., 2020; Viktoria and Aida, 2020; Todri et al., 2021) were conducted to cover more than one country. Other studies include only one country. Surveys and questionnaires were mostly used as measurement tools in the study. Due to pandemic restrictions, online data collection approaches were preferred in the data collection process.

Students' views on distance learning are grouped under four themes. These themes are perception and attitudes, advantages of distance learning, disadvantages of distance learning, and challenges for distance learning.

Perception and Attitudes Toward Distance Learning

Students' attitudes toward distance learning differ according to the studies. In some studies (Mathew and Chung, 2020; Avsheniuk et al., 2021), it is stated that especially the students' attitudes are positive, while in some studies (Bozavlı, 2021; Yurdal et al., 2021) it is clearly stated that their attitudes are negative. In addition, there are also studies (Akcil and Bastas, 2021) that indicate that students' attitudes are at a moderate level. The transition to distance learning has been a source of anxiety for some students (Unger and Meiran, 2020).

When the students' satisfaction levels are analyzed, it is obvious from the research (Gonçalves et al., 2020; Avsheniuk et al., 2021; Bakhov et al., 2021; Glebov et al., 2021; Todri et al., 2021) that the students' satisfaction levels are high. In some studies, it is pronounced that the general satisfaction level of the participants is moderate (Viktoria and Aida, 2020; Aldossary, 2021; Didenko et al., 2021) and low (Taşkaya, 2021).

When students compare face-to-face and online learning methods, they state that online learning has opportunities to compensate for their deficiencies due to the pandemic conditions (Abrosimova, 2020) and but they prefer face-to-face learning (Gonçalves et al., 2020; Kaisar and Chowdhury, 2020; Bakhov et al., 2021). Distance learning is not sufficiently motivating (Altun et al., 2021; Bozavlı, 2021), effective (Beltekin and Kuyulu, 2020; Bozavlı, 2021), and does not have a contribution to students' knowledge (Taşkaya, 2021). Distance education cannot be used in place of face-to-face instruction (Aldossary, 2021; Altun et al., 2021).

Advantages of Distance Learning

It is mostly cited advantages that distance learning has a positive effect on achievement and learning (Gonçalves et al., 2020; Lin and Gao, 2020; Aldossary, 2021; Altun et al., 2021; Şahin, 2021). In addition, in distance learning, students can have more resources and reuse resources such as re-watching video (Önöral and Kurtulmus-Yilmaz, 2020; Lamanauskas and Makarskaitė-Petkevičienė, 2021; Martha et al., 2021).

Distance learning for the reason any time and everywhere learning (Adnan and Anwar, 2020; Lamanauskas and Makarskaitė-Petkevičienė, 2021; Todri et al., 2021). There is no need to spend money on transportation to and from the institution (Lamanauskas and Makarskaitė-Petkevičienė, 2021; Nenakhova, 2021). Also, staying at home is safe during pandemics and less stressful for students (Lamanauskas and Makarskaitė-Petkevičienė, 2021).

Challenges and Disadvantages of Distance Learning

Distance learning cannot guarantee effective learning, the persistence of learning, or success (Altun et al., 2021; Benadla and Hadji, 2021). Students state that they have more works, tasks, and study loads in the distance learning process (Mathew and Chung, 2020; Bakhov et al., 2021; Didenko et al., 2021; Nenakhova, 2021). Group working and socialization difficulties are experienced in distance learning (Adnan and Anwar, 2020; Bozavlı, 2021; Lamanauskas and Makarskaitė-Petkevičienė, 2021). The absence of communication and face-to-face interaction is seen a disadvantage (Didenko et al., 2021; Nenakhova, 2021).

It is difficult to keep attention on the computer screen for a long time, so distance-learning negatively affects concentration (Bakhov et al., 2021; Lamanauskas and Makarskaitė-Petkevičienė, 2021). In addition, distance education prompts some physical and psychological health problems (Kaisar and Chowdhury, 2020; Taşkaya, 2021).

Devices and internet connection, technical problems are mainly stated as challenges for distance learning (Abrosimova, 2020; Adnan and Anwar, 2020; Mathew and Chung, 2020; Bakhov et al., 2021; Benadla and Hadji, 2021; Didenko et al., 2021; Lamanauskas and Makarskaitė-Petkevičienė, 2021; Nenakhova, 2021; Taşkaya, 2021; Şahin, 2021). In addition, some students have difficulties in finding a quiet and suitable environment where they can follow distance education courses (Taşkaya, 2021). It is a disadvantage that students have not the knowledge and skills to use the technological tools used in distance education (Lassoued et al., 2020; Bakhov et al., 2021; Didenko et al., 2021).

DISCUSSION

The purpose of this study is to ascertain university students' perceptions about distant education during COVID-19. The study's findings are intended to give context for developers of distant curriculum and higher education institutions.

According to Toquero (2020), academic institutions have an increased need to enhance their curricula, and the incorporation of innovative teaching methods and tactics should be a priority. COVID-19's lockout has shown the reality of higher education's current state: Progressive universities operating in the twenty-first century did not appear to be prepared to implement digital teaching and learning tools; existing online learning platforms were not universal solutions; teaching staff were not prepared to teach remotely; their understanding of online teaching was sometimes limited to sending handbooks, slides, sample tasks, and assignments to students via email and setting deadlines for submission of completed tasks (Didenko et al., 2021).

It is a key factor that student satisfaction to identify the influencers that emerged in online higher education settings (Parahoo et al., 2016). Also, there was a significant positive relationship between online learning, social presence and satisfaction with online courses (Stankovska et al., 2021). According to the findings, the attitudes and satisfaction levels of the students differ according to the studies and vary in a wide range from positive to negative attitudes.

According to the study's findings, students responded that while online learning is beneficial for compensating for deficiencies during the pandemic, they would prefer face-to-face education in the future. This is a significant outcome for institutions. It is not desirable for all students to take their courses entirely online. According to Samat et al. (2020), the one-size-fits-all approach to ODL implementation is inapplicable since it not only impedes the flow of information delivery inside the virtual classroom, but it also has an impact on psychological well-being because users are prone to become disturbed.

In distance learning, students can have more resources and reuse resources such as re-watching videos. So, distance learning has a positive effect on achievement and learning. Alghamdi (2021) stated that over the last two decades, research on the influence of technology on students' academic success has revealed a range of good and negative impacts and relationships, as well as zero effects and relationship.

The result also shows that distance education prompts some physical and psychological health problems. Due to the difficulty of maintaining focus on a computer screen for an extended period of time, remote education has a detrimental effect on concentration. There is some evidence that students are fearful of online learning in compared to more traditional, or in-person, in-class learning environments, as well as media representations of emergencies (Müller-Seitz and Macpherson, 2014).

Unsatisfactory equipment and internet connection, technical difficulties, and a lack of expertise about remote learning technology are frequently cited as distance learning issues. Due to the pandemic's quick move to online education, many schools have an insufficient infrastructure. Infrastructure deficiency is more evident in fields that require laboratory work such as engineering (Andrzej, 2020) and medicine (Yurdal et al., 2021).

Conclusion and Recommendation

To sum up, students' opinions and levels of satisfaction vary significantly, ranging from positive to negative. Distance learning for the reason any time and everywhere learning. Distance learning has a positive effect on achievement and learning. Staying at home is safe during pandemics and less stressful for students. Distance education prompts some physical and psychological health problems such as fear, anxiety, stress, and losing concentration. Due to the pandemic's quick move to online education, many schools have an insufficient infrastructure. Future researchers can investigate what distance education models can be that will eliminate the complaints of students. Students' positive attitudes and levels of satisfaction with their distant education programs have an impact on their ability to profit from the program. Consequently, schools wishing to implement distant education should begin by developing a structure, content, and pedagogical approach that would improve the satisfaction of their students. According to the findings of the study, there is no universally applicable magic formula since student satisfaction differs depending on the country, course content, and external factors.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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The Impacts of Fears of COVID-19 on University Students' Adaptability in Online Learning

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Fears of COVID-19 covered humans on earth quickly since the first appearance of Coronavirus in Wuhan in 2019. Consequently, online learning has been deployed widely to ensure the continuity of education in the context of the pandemic. The mixed-method study was conducted to examine the extent of fears Vietnamese students' perceived as well as their learning adaptability, using the Fears of COVID-19 Pandemic (FCV19) scale and Adaptability scale as research instruments. Data was analyzed relied on Mean statistics from SPSS22, combined with Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) to examine the influences of fears of COVID-19 on students' online learning adaptability. The results triangulated with qualitative data from open-ended questions showed that students were moderately afraid of the COVID-19 pandemic but had a high level of adaptability in online learning. Additionally, fears of COVID-19 also had little impact on students' online learning adaptability. Instead, students showed off some other fears preventing their virtual learning, including (1) fears of wasting time and money for a shoddy online education, (2) fears of loneliness and laziness, (3) fears of distracting factors when learning online, and (4) fears of lacking learning materials.

Keywords: fears of COVID-19 pandemic, FCV19, adaptability, online learning, mixed-method

INTRODUCTION

COVID-19 has become one of the phobias worldwide since its first appearance in Wuhan, China, at the end of 2019. It is believed to cause most depression, anxiety, fears of death, losing loved ones, and post-traumatic disorder (Keyes et al., 2014). 2020 was when the United States and most European countries like the United Kingdom, Germany, Italy, Spain, and Portugal encountered the hazardous time fighting against the pandemic; meanwhile, in Asia in 2021, led by India with the records of death tolls and infections, followed by many other Asian countries like the Philippines, Indonesia, Thailand, and Vietnam.

Switching to online education indeed becomes a must wherever there are infected cases. Accordingly, online education is implemented in different forms, including synchronous and asynchronous, or other tutoring models, including in-person, e-mail, virtual tutoring (Hangout/Google Meet), and WhatsApp (Pérez-Jorge et al., 2018, 2020). In Vietnam, educators also deploy online teaching on social networks such as Zalo and Facebook (Van and Thi, 2021b).

Unfortunately, students are considered the most vulnerable due to facing strict social distancing periods and studying in the limit of learning resources (Rodríguez-Hidalgo et al., 2020). Some other hindrance factors discussed include the lack of social interaction, cost and access to the Internet, technological issues, or even students' worriment about the quality of online education (Van and Thi, 2021a). When fears become one of the frequent common emotions in the time of the pandemic, there are plenty of studies conducted to investigate the impacts of fears of COVID-19 on different groups of people and living conditions, for example, medical staff (Urooj et al., 2020), patients with underlying medical conditions (Guven et al., 2020; Colomer-Lahiguera et al., 2021), senior citizens (De Leo and Trabucchi, 2020), prisoners (Pattavina and Palmieri, 2020; Johnson et al., 2021). Whether fears of COVID-19 impose any influences on students' online learning adaptability has intrigued stakeholders for seeking the answers.

The idea of this study arose when Ho Chi Minh City and other localities in the Mekong Delta of Vietnam were sinking in the huge wave of COVID-19 infected cases and death tolls. The pandemic started in late the academic year and became more severe during the summertime of 2021. It was coincident with summer vacation; however, to most high school students, this was a revision time for National High School Examination and the summer semester for university students. By the same token, a plethora of Vietnamese students have encountered the second time of online learning. Researching the correlations between fears of COVID-19 and students' online learning adaptability help to gain more insight into the psychological characteristics of students in the region. It may also help to propose necessary interventions from stakeholders for students' normal psychological recovery in the post-COVID-19 pandemic.

THEORETICAL BACKGROUND

Fears of COVID-19 Pandemic

The Oxford online dictionary defines "fears" as the bad feelings someone has when being in danger or frightened. In the educational environment, fears may cause significant psychological distress, fears of vagueness, and uncertainty, which could directly impose unpleasant effects on overall learning, academic achievement, and the general well-being of students (Elsharkawy and Abdelaziz, 2021). Similarly, Arpaci et al. (2020) considered fears a multifaceted factor, often one of the most crucial underlying factors of conceded mental health and well-being. During the COVID-19 pandemic, fears become one of the most frequent emotions that may spread much faster from one to another than the disease itself (Arpaci et al., 2020).

Online Learning in the Time of COVID-19 Pandemic

The outbreak of a fatal and infectious disease named COVID-19 has caused the closure of most educational institutions worldwide. To maintain the continuity of education in the context of the COVID-19 pandemic, online learning was implemented as no more than an option, but a necessity (Singh and Thurman, 2019), even when some underdeveloped and developing nations have been unready. For instance, Pakistanis education pointed out the undesired learning satisfaction among students, whose online learning conditions were restricted not only in technical issues but also monetary issues (Adnan and Anwar, 2020).

In Vietnam, as one of the developing countries in Southeast Asia, online learning has been implemented to meet the demand of the global educational trend; however, it also imposes a wide range of difficulties for the authorities and educators. With regard to the online learning barriers in the current context, most Vietnamese students, especially students in the Mekong Delta, considered that limited social interaction had caused a lot of challenges for them when learning online (Van and Thi, 2021a,b). Subsequently, the so-called cost and access to the Internet and some technical issues have prevented students from becoming successful online learners. These challenges were followed by learners' skepticism about learning quality when most of them thought that they paid more than what they knew and could not understand as effectively as when they were on campus.

Students' Adaptability

Adaptability is understood as appropriate cognitive, behavioral, and/or affective adjustment in the face of uncertainty and novelty (Martin et al., 2013). The American Psychological Association's (APA) has officially defined adaptability as "the capacity to make appropriate responses to changed or changing situations; the ability to modify or adjust one's behavior in meeting different circumstances or different people" (VandenBos, 2007). Prior studies highlighted the vital role of adaptability in constructing students' engagement and achievements (Martin et al., 2013; Collie et al., 2017), reducing students' failure dynamics (Martin et al., 2015). Holliman et al. (2018) especially emphasized the connection between adaptability and students' engagement and long-term achievement. As a matter of fact, adaptability plays an essential role in students' positive development (Martin et al., 2021).

RESEARCH METHODOLOGY

Research Aims

The study was conducted to measure the levels of fear among students about the COVID 19 pandemic. We also wanted to assess Vietnamese students' adaptability to online learning in the context of the pandemic. Ultimately, we aimed to investigate whether such fears of COVID-19 affect their adaptability to online learning or not.

To address these aims, the following questions were posed:

1. To what extent do students perceive fears of the COVID-19 pandemic?
2. What are students' adaptability levels to online learning in the context of the COVID-19 pandemic?
3. To what extent do fears of the COVID-19 pandemic affect students' online learning adaptability?

Research Design

A mixed-method study was designed to find out answers to research questions. Accordingly, data will be collected in parallel, analyzed separately, and merged to provide a complete understanding of research problems (Creswell and Creswell, 2017). Mixed-method studies are also preferred since they provide a deeper and broader understanding of the phenomenon than the study taken only with a qualitative or quantitative approach (Hurmerinta-Peltomäki and Nummela, 2006).

In this study, the FCV19 Scale and Adaptability Scale were adapted to confirm the extent of students' fears of the pandemic and their adaptability to online learning, with the first use of Exploratory Factor Analyses. Then, we employed statistics on means of these scales and ran CFA and SEM to examine the influences of FCV19 on students' adaptability in online learning. Also, in this study, we wanted to get insights into students' explanations for their rating with items in the survey; open-ended questions were added to call for students' answers. To ensure the validity and reliability of answers from open-ended questions, we followed Brislin's model of translation (Brislin, 1986), which is widely accepted and used to translate quantitative instruments but is time-consuming (Lopez et al., 2008). Accordingly, one researcher took the responsibility to translate the answers from Vietnamese to English. The second researcher would then back-translate the results from English into Vietnamese. The third researcher compared both versions to check accuracy and consistency. Any discrepancies would be negotiated before figuring out the final answers.

Both quantitative and qualitative findings were triangulated to write up the results. The research model is illustrated in **Figure 1**.

Research Instruments

To solve the research issues, we adapted the FCV19 scale (Ahorsu et al., 2020) and Adaptability scale (Martin et al., 2012) as the research instruments. According to Natalia and Syakurah (2021), FCV19 Scales is useful to evaluate the fear of the COVID-19 pandemic. The Adaptability Scale (Martin et al., 2013) is also a comprehensive measurement for assessing students' cognitive, behavioral, and emotional adaptability (Holliman et al., 2021).

There are sixteen items that help measure learners' fears of the pandemic and their online learning adaptability in the current context. A Vietnamese version was created to help learners familiarize themselves with the questionnaire before launching it to collect data on Google Form in September 2021. Table A1 displays all the variables measured for the study's primary constructs. Participants were asked to choose the extent they agree with each statement, ranging from (1) Completely disagree to (5) Completely agree.

An Exploratory Factor Analysis (EFA) with Principle Axis Factoring and Promax rotation was used in the study. The results showed that FCV19 was a unidimensional factor when the seven items were loaded into only one group, with Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) at 0.878 and the initial eigenvalues were greater than 1. The significant level of Bartlett's was at 0.000, proving all the variables were correlated. They were accounted for 62.64 of all variance. According to Hair et al. (2006): "... in the social sciences, where information is often less precise, it is not uncommon to consider a solution that accounts for 60% of the total variance (and in some cases even less) as to satisfactory" (p. 104).

Simultaneously, a similar EFA was applied for the Adaptability scales, with KMO at 0.900, a significant Bartlett's test level at 0.000, and qualified initial eigenvalues (> 1). Noticeably, nine items were loaded into two groups of factors, namely the Cognitive-behavioral factor and the Affective factor, precisely the same as the result of Martin et al.'s (2012) study. Details about the results of EFA for these scales were displayed in **Tables 1–3** as follows.

Participants

567 university students in the Mekong Delta, who were learning online due to the COVID-19 pandemic, joined in answering

TABLE 1 | Total variance explained of the FCV19 scale and adaptability scale.

Factors		Initial eigenvalues		
		Total	% of Variance	Cumulative%
FCV19	FCV19	4.385	62.641	**62.641**
Adaptability	Cognitive-behavior factor	5.084	56.485	56.485
	Affective factor	1.116	12.395	**68.881**
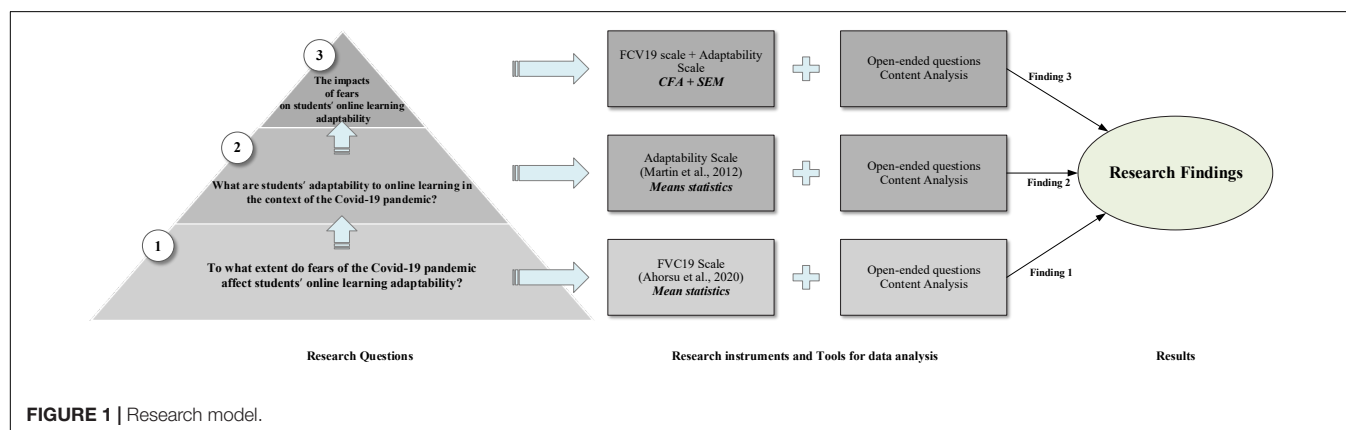
FIGURE 1 | Research model.

TABLE 2 | Pattern matrix of the FCV19.

	Factor
	1
F1	0.677
F2	0.694
F3	0.772
F4	0.774
F5	0.805
F6	0.756
F7	0.776

TABLE 3 | Pattern matrix of the adaptability scale.

Factors	
1	2
0.725	0.411
0.847	0.538
0.816	0.558
0.785	0.536
0.609	0.573
0.750	0.614
0.534	0.855
0.488	0.808
0.591	0.708

a web-based questionnaire. They are from 18 to 24 years old, including 199 male students (35.1%) and 368 female students (64.9%). Most of them came back to their hometown, and a few were stuck in the university regions. They are living in 13 provinces in the Mekong Delta. According to statistics on the locals with COVID-19 infected cases, there are 503 students (87.1%) living in the pandemic areas, only 73 students (12.9%) being in non-COVID-19 regions. Details about distribution of participants and the COVID-19 risk levels by provinces will be illustrated in **Figures 2**,**3**.

FINDINGS

Students' Perceived Fears of the COVID-19 Pandemic
Results From Quantitative Analysis
To evaluate the extent of fears students perceived regarding the COVID-19 pandemic, the mean statistics (**Table 4**) showed a moderate level ($M = 3.58$, $SD = 0.84$). It means that students were quite afraid of the pandemic.

Specifically, among the seven items constructing the FCV19 scale, F1 *(I am most afraid of coronavirus-19)* and F2 *(It makes me uncomfortable to think about coronavirus-19)* got the highest levels ($M = 4.12$, $SD = 0.96$, and $M = 4.06$, $SD = 0.963$, respectively). F3 *(My hands become clammy when I think about coronavirus-19)*, F6 (I cannot sleep because I'm worrying about getting coronavirus-19), and F7 *(My heart races or palpitates when I think about getting coronavirus-19)* were rated just above the

neutral level (**Figure 4**), which mean that students were afraid of the COVID-19 but not extreme toward these issues.

When participants were invited to write short answers for the open-ended question: "How can you describe your feeling when there are more and more COVID-19 positive cases in Vietnam?," among 567 responses recorded (100%), almost all participants (98%) revealed their worriment about the pandemic, except for 12 respondents (2%) who said that they were still OK, just normal, or calmed down enough with the COVID-19 news. Statistics on the frequencies of words that appeared in their answers showed that there were 495 times students mentioned the word "worry," 212 times of "fears," 77 times of "confused," 43 times of "sad," 22 times of "insecure," and 6 times of "bored." It can be seen that the COVID-19 seemed to cover uncertain living conditions to almost all students. This section will be continued by some typical reasons for students' fears of the COVID-19 pandemic.

Lateness in Graduation Time
It sounded like a paradox when educational institutions implemented online learning is to ensure students' continuity of education and their time to graduate. The results showed that 74/567 (13.1%) were terrified of late graduation from the university. Specifically, some said that they were seniors and some experimental courses required them to attend the traditional learning form. Their fears of the COVID-19, to be more precise, are their phobias when they become passive in the changing learning condition.

"I am scared of the pandemic, especially when it lengthens the time I graduate. I cannot finish practicum courses, which makes me feel hard to eat well and sleep well." said Respondent #37.

A smaller number of 53/567 (9.3%) students thought they might fail the exams because they could not concentrate on their study. They were bombarded with information about the numbers of people dying due to the COVID-19 in Vietnam and the world; even the increasing number of infected cases in their regions. Losing concentration leads students to risks of failures and lateness in their graduation plan.

"Sometimes, when we are learning and there is suddenly an announcement about an increase in cases, I feel distracted a lot. It will be worse if my friends bring the story to share with my teacher and other classmates, the lesson will be interrupted and we cannot re-focus to study." said respondent #5.

"I am trying to stay home and learn online, but I continuously wonder when the locals come and grasp us to the isolation area. I know that people can be positive with Corona easily. I cannot concentrate on learning whenever I think of it. What if I cannot keep up with my friends and fail the course? When will I graduate?" said Respondent #5.

Infection and Death
112/567 (19.8%) students said that they were afraid of being positive for the virus when more and more people around them were infected. Respondent #69 wrote: *"I do not know when I am positive with Coronavirus, though I try to follow the government policies to stay home during the quarantine period."* Similarly,
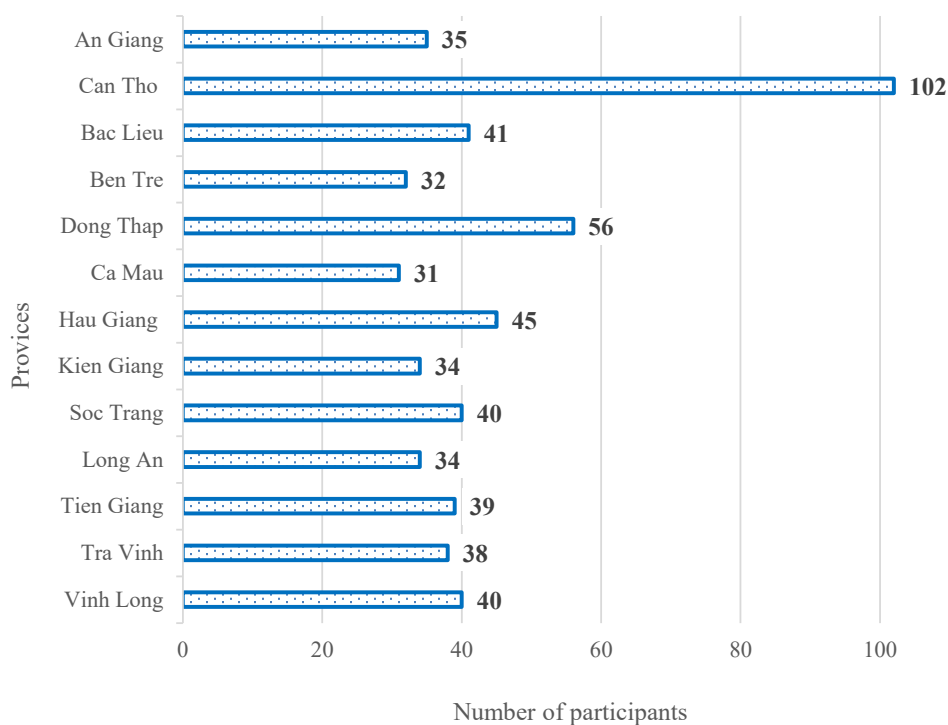
FIGURE 2 | Distribution of participants by provinces.
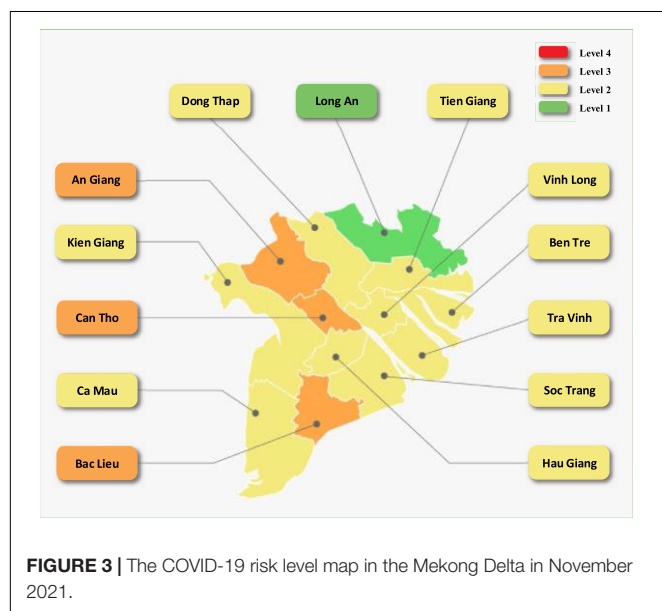
FIGURE 3 | The COVID-19 risk level map in the Mekong Delta in November 2021.

Respondents #1, #91, and #355 said that: *"I am afraid of losing my life because of the COVID."* Twelve other students showed their expectation not to lose anyone due to the pandemic, resulting from the fact that they have witnessed a lot of stories about people who died and the sorrowfulness that their families suffered. All depicted a very blue picture that became a phobia for everyone on earth.

"I am still young, and I have so many things to do in the future. I do not want to end my life due to Coronavirus." said Respondent #466.

"I saw a lot of videos on Facebook about families in Ho Chi Minh City; just in a few days, they lost their father, their mother, and they cannot see them at the last second. A lot of children become innocent orphans. I feel blue about it. I cannot imagine what will happen to me in the future." said Respondent #77.

Students' Online Learning Adaptability
Results From the Quantitative Analysis

Students' online learning adaptability was evaluated through its mean values. As shown in **Table 4**, the results indicated that students have high adaptability in learning online in the context of the COVID-19 pandemic, not only in Cognitive-behavior ($M = 4.21$, $SD = 0.632$) but also in Affective aspects ($M = 4.19$, $SD = 0.781$). Noticeably, as can be seen in **Figure 5**, all means of factors in the scales fluctuated from 4.17 to 4.25, testifying that students agree with the survey items. More precisely, they can adapt very well to a changing learning condition.

TABLE 4 | Mean statistics of the FCV19 and adaptability scale.

		Mean	SD
	Fears	3.58	0.960
Adaptability	Cognitive-behavioral factor	4.21	0.632
	Affective factor	4.16	0.781
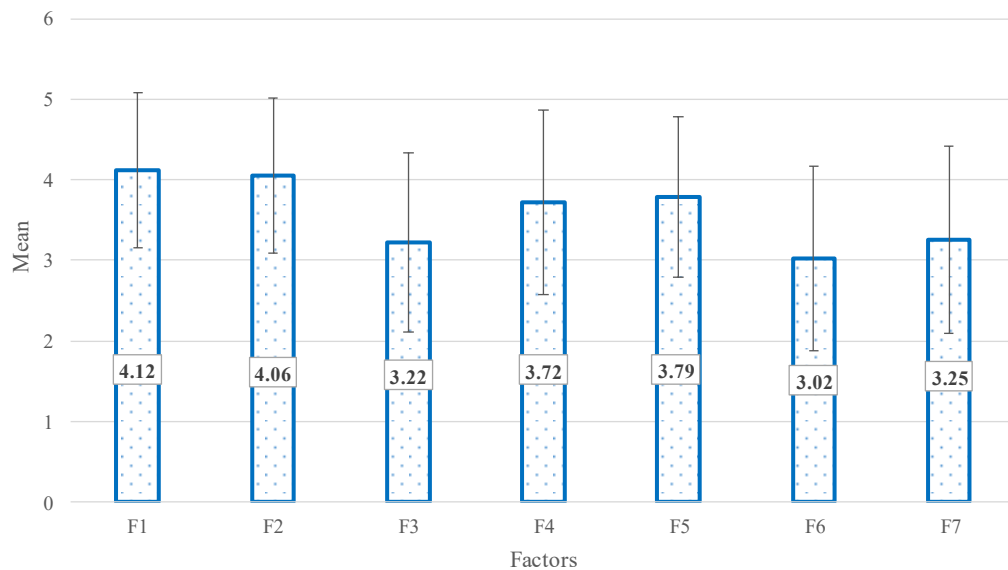
FIGURE 4 | Means of each factor in FCV19 scale (*N* = 567).
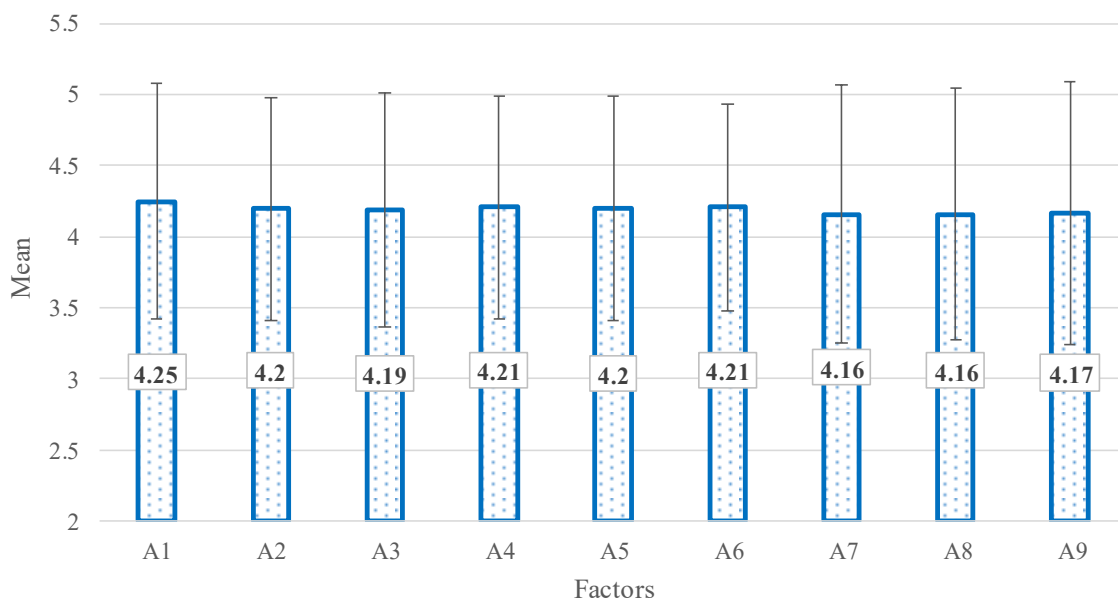
FIGURE 5 | Means of each factor in Adaptability scale (*N* = 567).

Students' Voice About Their Adaptability

When answering questions regarding students' FCV19 and students' adaptability, 64/567 (11.4%) students believed that Coronavirus's existence was not a simple issue, but it will challenge humans for a long time. Therefore, learning to adapt to the pandemic becomes a must to help people feel better. It is surprising to see a strong sense of responsibility and self-discipline from students that can form the so-called "students' solid mental preparation" and "students' strong belief in the governmental policies."

Students' Solid Mental Preparation in Response to the COVID-19 Pandemic

142/567 (25%) students joining the survey said they were scared of the pandemic; however, they recognized the importance of learning. They know how to adapt to reality and balance their mental phobia with their responsibilities while and after the pandemic. 132/567 (23.2%) students said they found information about the virus, including the common symptoms if they were accidentally positive with, how to protect themselves, how to care for themselves, and how to take care of their family members

these days. All proved the fact that students had known how to confront the epidemic. They are not passive and weak to be attacked by the virus.

Students' Strong Belief in the Governmental Policies

97/567 (17.1%) students said they were worried about the pandemic, but it was not much because the Vietnamese government has implemented the right policies that help to protect everyone. The problem is how individuals strictly follow those directions to protect themselves and the whole community. 155/567 (27.3%) students confidently claimed that they obeyed every demand from their local authority, like joining 5K instruction, taking national vaccination plan, following Directives numbers 15 and 16 during social distancing periods. As a fact of the matter, they all said that they were protected well by the government, and they had no reasons to worry about the COVID-19 longer. These claims sometimes showed their innocence, but in general, proved students' steady state of mind in the fight against the COVID. Since then, they felt more secure to study online in the context of the pandemic.

> "...I think the more I fear, the more unstable I will be. This will make me more worried. With the instructions given by the state and everyone doing as well as now, we will win the pandemic soon; everything will return to normal. Always thinking positively also greatly contributes to avoiding the fear of the Corona pandemic." said respondent #366.

> "To deal with Coronavirus, I think obeying the government's directives well will reduce the spread and fear." said Respondent #14.

> "I feel that our government has implemented many correct directives to prevent the epidemic, so I have nothing to worry about. I always study in a comfortable posture without worrying; I also try to limit leaving the house when not necessary to help the disease not spread much." said Respondent #106.

The Impact of Fears of COVID-19 Pandemic on Students' Online Learning Adaptability

Results From the Quantitative Analysis

Measurement Model Testing

Evaluating the measurement model is initial in every SEM process. Three main criteria were used to assess the model, including the Reliability, Composite Reliability (CR), and Average Variance Extracted (AVE) (Nunnally, 1978; Hair et al., 2006). **Table 5** shows that Cronbach's alpha is above 0.7, confirming the strong reliability of all measures. CR fluctuates from 0.836 to 0.903, which exceeds the recommended value (0.7) (Hair et al., 2006). The AVE value for all constructs is greater than 0.5, confirming the latent model variables' confidence and validity. The discriminant validity of the measurement model (**Table 6**) was assessed based on the evaluation of whether the correlation and coefficient among factors are different from 1; and comparing the square root of AVE, which must be higher than the correlation between one construct and the others (Fornell and Larcker, 1981). **Figure 6** will display the structural model results.

TABLE 5 | Evaluating the reliability of research instruments.

	Constructs	Cronbach's alpha	CR	AVE
Fears	FCV19	0.900	0.903	0.573
Adaptability	CBA	0.888	0.888	0.573
	AA	0.831	0.836	0.630

TABLE 6 | Fornell-Larcker criterion analysis.

	AVE	MSV	FCV19	CB	A
FCV19	0.573	0.109	**0.757**		
CBA	0.573	0.497	0.330***	**0.757**	
AA	0.630	0.497	0.219***	0.705***	**0.794**

*CBA, Cognitive-behavioral Adaptability; AA, Affective Adaptability. "***" means "000".*

As can be seen in **Table 7**, using the 95% confidence standard, the sig of the FCV19 affecting Cognitive-behavioral Adaptability (CBA) and Affective Adaptability (AA) is equal to 0.000, so these relationships are all significant. It can conclude that FCV19 has influenced participants' online learning adaptability (A).

Specifically, **Table 8** showed that the R-squared value of Adaptability (A) is 0.102, which mean that FCV19 has the levels of impact at 10.2% on Adaptability. To conclude, FCV19 merely explains 10.2% its influence on learners' adaptability within the context of pandemic.

Qualitative Results About the Impacts of Fears of COVID-19 Pandemic and Students' Online Learning Adaptability

The results after qualitative analysis indicated that FCV19 did not really scatter students' online learning adaptability. It is only a minor factor that governs adaptability and especially, it is a mediator to a series of other influencing factors for students' online learning.

> "Currently, Corona has become more familiar to my study, which means it doesn't dominate my study more. Being at home during quarantine and lockdown periods makes me feel very cramped, so I prefer to go to school. But I have no more option but learning online. In the past, I might have been late to school because of the erratic weather at noon, but when I study online, I am never late. In the past, I might not be able to concentrate in class because I did not have time to drink coffee or sleep enough, and I had to go back and forth many times, making me feel tired. Now I can balance my eating, sleeping, and learning during the quarantine period. After all, Corona is scary, but I don't want it to mess up all the order in my life in a senseless way." said Respondent #139.

> "...FCV19 impacts my online learning, but just a little! Because in many situations, people also need to learn and adapt." said Respondent #329.

Other fears related to COVID-19 influencing on students' online learning adaptability can be mentioned as: (1) Fears of Time and money consuming with a shoddy online education, (2) Fears of loneliness and laziness when learning online, (3) Fears of distracting factors when learning online, and (4) Fears of lacking learning materials.

FIGURE 6 | Structural model results.
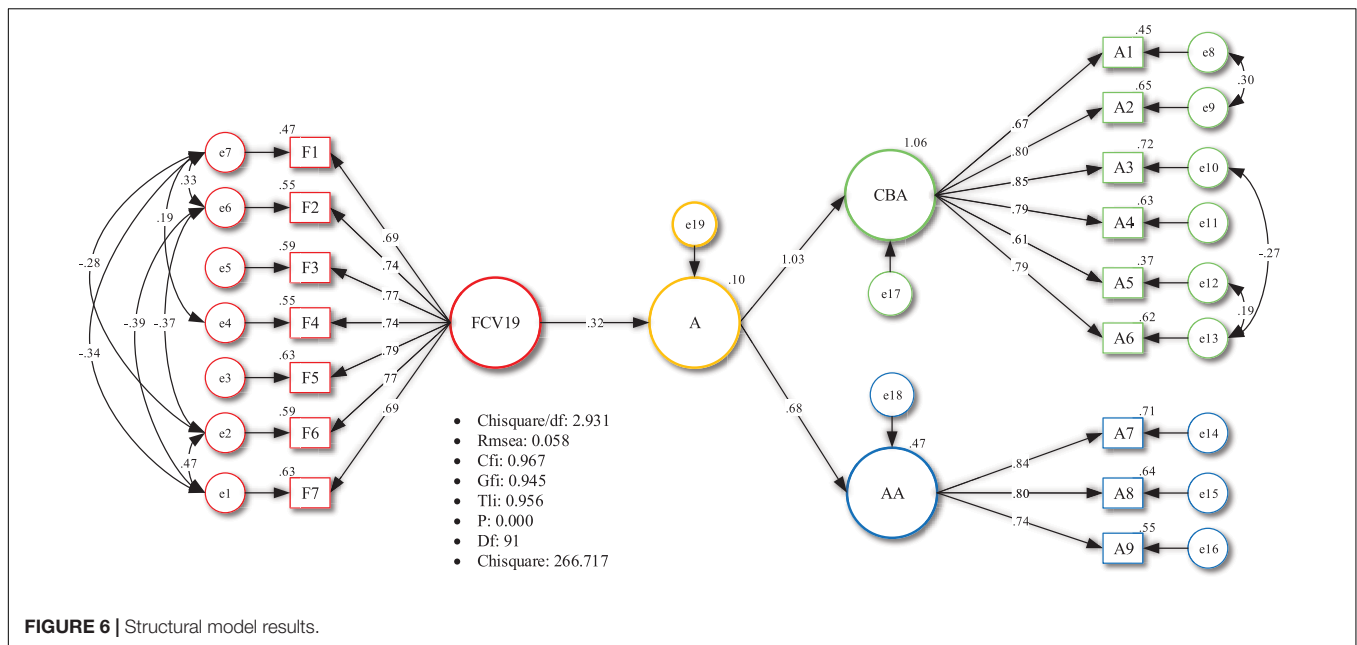
TABLE 7 | Structural model path coefficients.

Correlations			Estimate	S.E.	C.R.	P	Standardized estimate
Adaptability (A)	←	FCV19	0.181	0.040	4.579	***	0.320
Cognitive-behavioral adaptability (CBA)	←	Adaptability (A)	1.097	0.197	5.557	***	1,031
Affective adaptability (AA)	←	Adaptability (A)	1.000				0.684

"*****" means "000".

TABLE 8 | Squared multiple correlations.

	Estimate
A	0.102
AA	0.467
CBA	1.063
A9	0.545
…	…

Time and Money Consuming With a Shoddy Online Education

To begin with, 94/567 (16.6%) students complained that the teaching quality is not worth the amount of money their parents invested in their studies now. 42/567 (7.4%) students firmly concluded that learning online is just a waste of time and money.

Concerning money earned in the time of the pandemic, it had pushed a tremendous strain on families' financial burden. When following directive No. 16 of the Vietnamese government, millions of people had to leave their work. Therefore, when the school fee is on the rise, many students tend to be upset and wonder why they have to pay more when they do not use any facilities from the university.

"*I'm petrified of the epidemic. If it is still happening for a long time, our economy is exhausted. There is no money to pay the tuition fee. Now, the tuition fee increases, who can stand it?*" said Respondent #247.

"*I believe FCV19 dominates my study a lot. I do not know when the pandemic ends, and I can come back to my school to study. There are many reasons that we must go to school, but we cannot. Especially in this period, my family cannot earn money, but we have to spend a lot on our daily meals, housing, and school fee. High tuition really makes me confused and worried so much*" said Respondent #409.

"*Studying at home makes me dominated. I feel very depressed and uninterested, like going to school. Learning online costs electricity (laptop, phone, Wi-Fi, etc.), yet I still have to pay the full tuition while the school saves it?*" said Respondent #480.

Some students were fed up with being charged a lot by learning online because they had to prepare laptops, computers, or smartphones, and the Internet connection that cost a lot of money from their parents in a susceptible period. Those are their true fears about the pandemic, they all believed.

Poor Online Teaching Quality

Up to 20 students claimed that they did not believe in the quality of online teaching. Learning online did not provide

enough knowledge about the subject (Respondents #198, #202, and # 218).

> "I have always had doubts about the quality of online teaching. I feel that online assessment is just something to deal with grades" said Respondent #7.

> "COVID-19 has influenced a lot on my study because I cannot go to school in a practical way. If studying online, how can I have enough knowledge and practice to pass the exam and complete the graduation course?" said respondent #198.

> "…the quality of online teaching is not as good as offline, so I really hope the school will postpone the next semester until everything is under control." said respondent #5.

Students' Fears of Loneliness and Laziness When Learning Online

Being mentally affected by the COVID-19 pandemic, some students find themselves alone when learning in the virtual environment. They admitted that online learning do not bring to learners social interaction factors. They cannot exchange information with their friends and teachers naturally. Consequently, students found it boring and were fed up with online learning. 28/567 (4.9%) students admitted that they were lazier when locked at home and studying online. All urged them to their dream of coming back to traditional education.

> "… Yes. The epidemic affects both my spiritual and academic life. Social distancing makes it impossible for me to exchange information, communicate and have fun with friends. Thereby, it makes my life boring and indirectly affecting the spirit of learning online." said Respondent #555.

> "Students are restricted from group discussions. Sitting for many hours in front of the computer screen makes our body tired, causes eye disease, and it is also difficult to remember the lesson content." said respondent #374.

Students' Fears of Distracting Factors When Learning Online

44/567 (7.8%) students said they could not concentrate on studying when they were learning at home. Finding out no motivation in learning from a separate place with their friends and teachers makes them "feel bored," and they cannot stay focused when being bombarded with a lot of housework, noise, and their threat to be falling behind their friends.

> "The biggest influence is the study space. I feel uncomfortable when learning at home. It makes my study stagnant, interrupted, and I always feel hard to re-concentrate on my study." said Respondent #30.

Students' Fears of Lacking Learning Resources

71/567 (12.5%) students admitted the inconveniences of online learning materials. Some said that they have to work with poor quality E-books, and the number of reference books was also inadequate.

> "I find it difficult to go to the photocopier to have printed books. I cannot look at e-books and take part in the lesson on Google Meet simultaneously. My phone can be broken if online learning continues taking place." said Respondent #344.

DISCUSSION AND CONCLUSION

Reports on Vietnamese Students' Fears of the COVID-19 Pandemic and Their Online Learning Adaptability

The findings indicated Vietnamese students' moderate level of fears of the COVID-19 pandemic ($M = 3.58$, $SD = 0.96$) and their high level of adaptability ($M = 4.19$, $SD = 0.62$) in learning online, based on the adaptation of the two research instruments, namely the FCV19 Scale (Ahorsu et al., 2020) and the Adaptability Scale (Martin et al., 2012). In addition, results from the qualitative analysis help clarify reasons students were scared of the pandemic and how they exposed their strong sense of adaptability in the context of the pandemic.

Concerning Vietnamese students' fears of the COVID-19 pandemic, most participants in this study agreed that they were most afraid of the pandemic (F1, $M = 4.12$, $SD = 0.960$), which made them feel uncomfortable to think about the Coronavirus (F2, $M = 4.06$, $SD = 0.963$). These findings proved humans' commonsense when the pandemic has been threatening anyone's life since 2019. Though many students have not witnessed the consequences of the pandemic in their current place of living, they have still been afraid of it through news and other updated information from the Internet. Nevertheless, students have rated just above average for other items of the FCV19 questionnaire; those are explained as items expressing different extreme levels of people's fears about the virus. Specifically, students almost approved the idea F5 ($M = 3.79$, $SD = 0.996$) that when watching news and stories about the pandemic on social media, they become nervous or anxious. Responses from the open-ended question also supported that statement when students felt blue whenever they heard reports about the number of people dying due to the COVID-19 or pictures of severe cases requiring ECMO and ventilator support. Therefore, students feared losing their lives because of Coronavirus ($M = 3.72$, $SD = 1.145$). Students disagree with three physical reactions: F3, F6, and F7; more precisely, when students were asked whether they felt clammy when thinking of the Coronavirus, or whether they could not sleep because of the pandemic, or their hearts race or palpitate when thinking about getting Coronavirus. It can be explained that at the time this study was conducted, there were not many infected cases in the region, and therefore students were not living in the center of the pandemic. Their voting would be, of course, different from those working in medical staff (Urooj et al., 2020) or high levels of fear from those with underlying medical conditions (Guven et al., 2020; Colomer-Lahiguera et al., 2021). It contributes to explaining the discrepancies in people's psychological responses in different situations. Moreover, the current study results, which were implemented on young adults aged 18–24, showed lower levels of fear than De Leo and Trabucchi (2020)'s results, which mainly surveyed fears of COVID-19 from the elderly. This helps hypothesize whether concerns about the COVID-19 increase with age, which will be a good premise for further research.

In addition, answers from the open-ended questions showed the two reasons students felt scared of the pandemic. Many

explanations supported well for the quantitative results, like students were afraid of losing their lives and being positive with the Coronavirus. Another reason for their fears, being different from the FCV19 scale, was students' fears of lateness in their graduation.

Regarding the high level of students' online learning adaptability (M = 4.19, SD = 0.62), they almost recognized the importance of learning to face an acute and prolonged illness like the COVID-19. Diverse explanations were found on their high awareness about the pandemic and their strong belief in their local policies. Just following all demands from the state strictly, students confidently claimed that they could protect themselves and other people effectively. This research finding was compatible with Elsharkawy and Abdelaziz (2021) when testifying that "...more knowledge and certainty regarding COVID-19 will relieve students' fears and worries about the disease and support their ability to adapt to any secondary effects in their lives." Under VandenBos's (2007) definition, Vietnamese students entirely had the capacity to make appropriate responses to changing situations.

The Impact of Fears of COVID-19 on Students' Online Learning Adaptability

The quantitative result from SEM displayed the fact that fears had little impact on students' online learning adaptability. Specifically, the FCV19 scale explained 10.2% of its influence on students' online learning adaptability. Therefore, the current study contributes to the literature another factor distracting students' virtual education. Moreover, a significant different value-adding to this research context was that this study generated the additional four other kinds of fears emerging from the fears of COVID-19 pandemic (FCV19) that dominated students' online learning adaptability, including (1) fears of wasting time and money for a shoddy online education, (2) fears of loneliness and laziness, (3) fears of distracting factors when learning online, and (4) fears of lacking the learning materials. This coincidence was compatible with Van and Thi (2021b) regarding factors hindering online learning in the Mekong Delta of Vietnam. It can be proven that FCV19 can be seen as another hindrance factor that prevented Vietnamese learners

from studying online in the current context. This was also similar to Rodríguez-Hidalgo et al. (2020) when students had to learn within the limit of learning resources.

PEDAGOGICAL IMPLEMENTATION

The current study highlighted that fear is another factor affecting students' online learning adaptability. Also, students were a little afraid of the COVID-19 pandemic but the high level of adaptation. This helps educators in the home country understand more about local students' psychological characteristics. The study also reinforced findings from previous studies about online learning barriers in the region. It will effectively contribute to education administrators having appropriate support for students to overcome difficulties in the online learning process, making online education more effective and accessible to all learners.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the FPT University, Can Tho, Vietnam. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DV took the main duty in launching the idea and writing the review of literature and findings. NK took responsibility in writing the introduction and research methodology. HT analyzed data and wrote discussion. All authors contributed to the article and approved the submitted version.

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APPENDIX

APPENDIX | The qualitative research instrument.

Constructs	Dimensions	Measure items	Item # in survey
Fears	Fears of COVID-19 (FCV)	I am most afraid of coronavirus-19. (F1)	1
		It makes me uncomfortable to think about coronavirus-19. (F2)	2
		My hands become clammy when I think about coronavirus-19. (F3)	3
		I am afraid of losing my life because of coronavirus-19. (F4)	4
		When watching news and stories about coronavirus-19 on social media, I become nervous or anxious. (F5)	5
		I cannot sleep because I'm worrying about getting coronavirus-19. (F6)	6
		My heart races or palpitates when I think about getting coronavirus-19. (F7)	7
Adaptability	Cognitive -behavioral factor. (CB)	I am able to think through a number of possible options to assist me in learning online amidst the COVID-19 pandemic. (A1)	8
		I am able to revise the way I think about learning online amidst the COVID-19 pandemic to help me through it. (A2)	9
		I am able to adjust my thinking or expectations to assist me learning online amidst the COVID-19 pandemic if necessary. (A3)	10
		I am able to seek out new information, helpful people, or useful resources to effectively deal with learning online amidst the COVID-19 pandemic. (A4)	11
		In uncertain situations, I am able to develop new ways of going about things (e.g., a different way of asking questions or finding information) to help me through. (A5)	12
		To assist me in learning online amidst the COVID-19 pandemic, I am able to change the way I do things if necessary. (A6)	13
	Affective factor (A)	I am able to reduce negative emotions (e.g., fear) to help me deal with uncertain situations. (A7)	14
		When uncertainty arises, I am able to minimize frustration or irritation so I can deal with it best. (A8)	15
		To help me through new situations, I am able to draw on positive feelings and emotions (e.g., enjoyment, satisfaction). (A9)	16

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Narrative Integrated Career Exploration Platform

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Career and technical education play a significant role in reducing high school and college dropouts as well providing necessary skills and opportunities to make suitable career decisions. The recent technological advances have benefited the education sector tremendously with the introduction of exciting innovations including virtual and augmented reality. The benefits of NL and game-based learning are well-established in the literature. However, their implementation has been limited to the education sector. In this research, the design and implementation of a Narrative Integrated Career Exploration (NICE) platform is discussed. The platform contains four playable tracks allowing students to explore careers in artificial intelligence, cybersecurity, internet of things, and electronics. The tracks are carefully designed with narrative problem-solving reflecting contemporary real-world challenges. To evaluate the perceived usefulness of the platform, a case study involving university students was performed. The results clearly reflect students' interest in narrative and game-based career exploration approaches.

Keywords: narrative-centered learning, vocational education, e-learning, game-based learning, education

INTRODUCTION

Narrative-centered Learning (NL) can be utilized to provide interactive and personalized form of content to students. In contrast to the traditional form of content delivery which are static and methodical in nature, NL exploits the key aspects from both gaming and storytelling that naturally engages the human brain. The dramatic growth of the video game industry, which generates three times more revenue than the film industry (Taylor, 2017), has shifted the focus of researchers into utilizing video gaming concepts to student learning curriculums (Eseryel et al., 2014; Shute et al., 2015). The vast advancement in technology has enabled video games to reach an unprecedented level of mainstream popularity. Particularly, due to better computer hardware and graphics, video gaming has been more realistic and complete. Virtual Reality (VR) technology is set to become the next great tool in video gaming and earlier research have shown promising results in implementing VR in education (Guazzaroni and Pillai, 2019; Zhang et al., 2020). Similarly, storytelling is effective for content delivery because it engages the emotional side of the brain. Using narratives, the students can learn to connect different concepts easily. Stories also have a lasting impact and as a result helps the students to remember the concepts for long time. Unlike video gaming research which has been emerging more recently, research into storytelling for education can be dated back to the 1980s (Farnsworth, 1981) with numerous works in the 1990s showing the positive impact of storytelling in classrooms (Mason, 1996). Research in the field of storytelling for learning is still active with the term "digital storytelling" finding its popularity. Digital storytelling utilizes

computer program to combine various digital media including text, images, audio narration, and video to convey a particular concept with the art of storytelling (Robin, 2016). However, simply assimilating gaming and storytelling would not be complex enough to deliver educational content or experiences. Consequently, researchers have looked into implementing the narratives in a virtual learning environment by utilizing Narrative intelligence which enables a human or a computer to organize experience into narrative (Riedl and Young, 2006). This approach often uses Narrative generation to dynamically generate stories that can be tailored to the user's taste and ability, providing almost an infinite outcomes and possibilities. A multitude of research work have applied this approach of NL in various domain, including microbiology (Rowe et al., 2009), mathematics (Rodrigues et al., 2017), negotiation training (Kim Hill et al., 2009), and language learning (Lewis, 2010).

Narrative-centered learning has the ability to integrate digital elements like interactivity, rewards, and feedback in compelling stories. This unified digital approach comprising of gaming and storytelling can engage young minds more effectively than traditional forms of knowledge delivery which are static and methodical in nature. Much of the existing research in this area focuses on improving academic learning outcomes and increasing student motivation levels in school environments. The increasing digitization of learning systems and the rise of flexible or work-from-home careers signifies the need for educational systems that integrate aspects of vocation and profession into the knowledge acquisition phase. This process will aid in preparing students with a greater sense of career readiness and cultivate practical hands-on skills before entering the industry or progressing in academia.

In this work, we propose an interactive career exploration platform that blends learning outcomes and connects them to real world careers using a narrative learning approach. A system with interactive module that allows for live decision making, as well as provides narrative real-world problem solving is designed and tested. The platform can assist students in developing a better understanding of the career they want to pursue, thereby increasing their overall career awareness, confidence in decision making and readiness for the future.

Related Works

Rowe et al. (2011) developed an game-based learning environment to study the impacts of NL on eighth grade students. Prior to playing the game, the students took a pretest. The learning environment was built on a 3D game engine using an United States state curriculum for eight-grade microbiology with the objective of supplementing regular classroom instruction. The game posed various problem-solving challenges to enhance their learning and another test was taken after playing the game. The comparison between the test scores showed that students who scored higher during the pretest displayed greater engagement with the NL environment. Another interesting finding is that both gamers and non-gamers achieved improved learning outcomes. In Min et al. (2017), the authors developed a game-based learning platform named *Engage* to introduce computational thinking to middle school students.

The curriculum for the NL environment was developed around the Computer Science principles course learning objectives for United States middle school students. A popular Machine Learning (ML) algorithm known as Long Short-Term Memory Networks (LSTMs) (Hochreiter and Schmidhuber, 1997) was developed to assess the performance of the students. The LSTM-based assessment framework infers students' post-competencies by using as an input the environment interaction data and pre-learning assessments. This method works better because it is more scalable unlike traditional methods which are built around hand-authored rules and statistical models. The results show that LSTM-based model outperformed the previous state-of-the-art approach in providing more accurate predictions of students' post-competencies. The authors in Emihovich et al. (2020) attempted to find the impacts of video gameplay on students' problem-solving skills. Undergraduate students were required to play either a roleplaying game or a brain-training game. The students were assessed on their problem-solving skills 20 h before and after playing the game using the Tower of Hanoi and the Programme for International Student Assessment (PISA) problem solving tests. The authors concluded that there was no significant difference between the results of both the groups on either problem. In other words, playing video game did not enhance the students' problem-solving ability but at the same time did not diminish their ability according to this work. A literature survey between 2008 and 2018 containing 20 empirical studies highlighted that 45% of the studies concluded to positive relationship between engagement and learning using game-based applications whereas 20% highlighted mixed findings (Shu and Liu, 2019). Another study of 273 trainees was conducted to investigate the impacts of gamified content on learning outcomes by assessing a text-based training against text-based training enhanced using game fiction (Armstrong and Landers, 2017). The results indicate that gamified content was more satisfactory to the subjects compared to plain content, although they did not find any significant change in declarative knowledge (i.e., facts). Another interesting conclusion was that the non-gaming group performed better at procedural knowledge (i.e., specific skill or task). This demonstrates that gamified content improved engagement but at some cost of effectiveness. A game-based learning environment was proposed in Sung and Hwang (2013) for students to share what they have learned during the game-playing process and determine the impacts of such applications on elementary school students. The role-playing game presents a narrative of an ancient kingdom where people are infected by poisoned river water and the character studies ancient medical books to find out the cure. Besides improving the learning attitudes and motivation of students, it also enhanced their learning achievement and self-belief that can be credited to the knowledge organizing and sharing facility of the gaming environment.

Implications to Career and Technical Education

Career and technical education (CTE) can be defined as "an educational strategy for providing young people with the

academic, technical, and employability skills and knowledge to pursue post-secondary training or higher education and enter a career field prepared for ongoing learning" (Brand et al., 2013). Instead of educating students about a limited set of skills needed for entry-level jobs, CTE focuses on preparing students for a career. Study shows CTE programs to be effective in reducing dropout rates, providing certifications that are recognized by the industry, encouraging post-secondary education admission, and allowing students to earn dual enrollment credits (Plank et al., 2005). According to Russell and White (2020), more than 70% of parents believed that CTE programs were beneficial in engaging students and were good for their child and more than 85% of business leaders believed CTE programs teach students transferrable skills that can benefit them in this economy. Despite the great benefits that CTE brings, there is an opportunity for technology to enhance the programs. According to McComb-Beverage (2012), students as young as 11 years old are able to actively engage in career development process by using career exploration activities. However, using traditional CTE approaches, career exploration is limited project-based learning and engagement with industry professionals (Castellano et al., 2014). These approaches provide limited exposure to students due to practical and resource limitations. For instance, a student interested in a lot of different careers will probably fail to explore them all through traditional approaches. This is where latest technology, NL-based gamified learning, can provide a groundbreaking career exploration platform. Using such an approach would not only allow students to explore all possible careers they are interested in, but also learn about the necessary skills associated with a career. Technology has already been shown to be effective in career guidance. According to Falco and Steen (2018), "computer-assisted career counseling, or career development activities that incorporate technology, appear to support retention, and academic achievement." A playable case study where students can act out a virtual internship and learn cybersecurity skills showed that using such experiential career exploration can allow students to make a better decision whether or not to pursue a career, understand the skills and trait needed for a career and increase their confidence to succeed in a specific career (Giboney et al., 2019). The proposed framework aims to provide students with a "week-in-the-life" simulated experience of a cybersecurity professional where the character is hired for a company called Cybermatics and has to solve intriguing problems as part of a storyline (Giboney et al., 2021). A comprehensive platform that can integrate the various career clusters (States Career Clusters, 2007) into a NL-based application has the potential to revolutionize career exploration and guidance. The impacts of VR on career education programs was explored by Kim and Lee (2021) on third grade students. The VR-based career education program demonstrated a high level of satisfaction and interest among students and had a positive effect on the student's perception of career. Similarly, Acosta et al. (2019) highlighted that augmented reality applications increased students' attention, relevance, confidence, and satisfaction in vocational education programs. These studies further signify a need for engaging technology in advancing CTE programs.

Based on the existing works in the literature, the significance of NL as well as game-based learning is well-established. Although they have been very effective in improving education, there currently exists no implementation of a system that can integrate NL-based gamified learning to provide a career exploration platform. Therefore, this manuscript presents a novel design, implementation, and testing of Narrative Integrated Career Exploration (NICE) platform utilizing NL and game-based learning. Following are the key contributions of this work:

1. It highlights the recent progress in narrative and discusses the immense potential of gamified and narrative learning for advancing CTE.
2. It proposes a design and experimental implementation of a novel NICE platform to facilitate career aptitude and exploration.
3. It performs a case study to assess the proposed platform and quantifies the satisfaction levels of students with such platforms and discusses future research directions.

MATERIALS AND METHODS

Narrative Integrated Career Exploration Overview

At the initial stage of development, a total of four playable career exploration tracks were deployed. Each track represents an emerging technology with projected significance in global industry and academia (Leoste et al., 2021). The tracks focus on applications of artificial intelligence, cybersecurity, internet-of-things, and electronic design. Each track session lasts an average of 15 min, and presents introductory concepts taught at the first-year level within ABET-accredited university courses. The hands-on experiments are designed based on engineering projects carried out in domain-specific industry internships, and graduate research projects at the American University of Sharjah (Cse Portal, 2021). Specifically, the theoretical content for each of the tracks were derived from the initial lecture material and companion laboratory assignments belonging to the following taught courses with their respective catalog codes offered at the American University of Sharjah: Artificial Intelligence (CMP433), Cybersecurity (COE444), Embedded Systems (COE410), and Electronic Circuits (ELE241). A detailed coverage of the material will be provided when each track is discussed.

The NICE framework incorporates certain aspects of gamification including the completion of discreet evolving tasks with attainable rewards (scores, unlocks, profile evaluation), immediate and delayed feedback for player selections, and permissible failure with the opportunity to reframe mistakes (McGonigal, 2011; Jordan Anstead, 2016).

Each track has the following elements as part of the student's user journey while navigating the platform:

i) A narrative framing a real-life application of the concept.
ii) Decision points integrating psychometric attributes in vocational questionnaires.

iii) Assessment points that serve to periodically reinforce the theoretical foundations by promoting active recall.

iv) Progress tracking and game-like incentives for engaged and successful completion of tasks.

For the psychometric attribute tracking, the traits are borrowed from the big five personality traits theory (Goldberg, 1993). As the traits are widely accepted in the research community as an initial screening for personality inclinations, this serves as a viable candidate for the scope of this project. The big five personality traits consist of openness, conscientiousness, extroversion, agreeableness, and neuroticism. Each of the five traits have sub-traits, which is reported in Nießen et al. (2020), for a total of thirty traits. These traits will be utilized for personalization of tracks, suggestions for improvement, and offering individualized avenues for decision making within the platform tracks.

To represent these traits, consider a set of $N = \{i_0 \ldots i_{29}\}$ elements, where the $i - th$ element corresponds to the ith trait as enumerated in **Supplementary Table 1**. The real number values between -1 and $+1$ determines the quantitative extent of a trait. Hence, if a person is extremely "dutiful" ($i = 8$ as shown in **Supplementary Table 1**), then the eighth element of their vector will be $+1$, whereas if they are moderately non-dutiful, then it would be -0.5. Note that if a trait is not relevant to a decision, it gets a score close to zero, whereas positively correlated traits are scored close to $+1$, and negatively correlated are scored close to -1. Consider a student exhibiting no discernable personality traits, their set representation would be a set of all zeroes. Consider a student who is NOT open ($i_0 \ldots i_5$), but VERY conscientiousness ($i_6 \ldots i_{11}$), their trait representation would quantitatively be for example, $\{-0.9, -0.8, -1, 0.95, -0.9, -1, +0.9, +0.8, +0.7, +0.6, +1, +0.8, 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0\}$.

Each choice for a decision point will have an associated 30-element set with predefined range of scores. If a user makes a certain choice, the associated array is added to their score. Thus, if they make five consecutive choices where the "trust" characteristic (trait $i = 18$) is $+1$, then the 18th element of their overall score would be $+5$, indicating that they are trustworthy. Note that we sum the arrays over all their decision choices. Therefore, if students select something that represents "warmth" in their first decision point but select something completely opposite in the next decision point, the scores will cancel out, and their overall "warmth" score would be approximately zero. As the students make more decisions and complete more tracks, their effective "personality" will ideally converge to a representation with minimal variance. The personality scores are intended to provide users with a meaningful guide to ultimately select their career and education paths that suits their overall personality. For instance, a user with an extremely introverted personality may not find careers such as event planner and human resources manager suitable.

Narrative Integrated Career Exploration Implementation

The NICE platform includes a user-friendly Graphical User Interface (GUI) offering several main features to students including playable career exploration tracks and tools for supporting career decision making. **Figure 1** presents an overview of the NICE system architecture and highlights its main components. A three-tier architecture is followed as per the modular client-server standards (Ramirez, 2000), comprising of a presentation layer (website page), an application layer (user tracking and decision making), and a data layer (databases and management). The architecture and programmatic flow are also displayed in **Figure 1**.

To elucidate the functioning of the platform, two sample scenarios are provided. In the first scenario, students access their profiles through the front-end web page using their credentials. Once they open a track, the narrative and visualization module are initiated by retrieving files from the database module. The narrative and visualization module continues to interact with the decision-making module to update the overall progress of the students on the student profile module. After students complete a track, their status is saved in the database module. Consequently, the email module is triggered to send a summary of their results, scores, and progress to their registered email address. In the second scenario, a teachers access their profiles through the front-end web page with their credentials. As an administrative user, the teachers can add, delete, and modify student information through the admin module. Moreover, they can contribute by introducing additional tracks with narratives, decisions, and concepts to the database module.

Learning is the process for acquisition of relevant knowledge or skills, and assessment is a way to observe the performance and generate insights about the learning of the individual. von Davier et al. (2019) proposes navigation as a critical component in the learning-assessment loop. Navigation is defined as the ability to find a path from one's current state to a goal state, and includes the utilization of social emotional learning skills, decision making skills, in conjunction with academic skills. Bobek 2017 states that understanding one's abilities, knowledge gained from education/work, exploration of goals, and management of college/job search actions are key dimensions for effective career planning. As such to generate reliable holistic insights along both the learning and social dimensions, it was imperative to introduce the traits and sub-traits outlined in **Supplementary Table 1**.

Within the decision making module, the decision points are application-based, assessment-based or behavior-based. In the former case, the student is prompted to make an estimated guess about what course of action is needed in a narrative scenario. For instance, in the AI track, the student is asked if they wish to consider a data pre-processing technique (missing value imputation, listwise deletion, feature scaling, etc.) before using machine learning algorithm. The expectation is that the student can piece together an appropriate solution given only basic information, such as the nature of the dataset, definitions of the feature-values, method of its acquisition, and purpose of the task. In the assessment-based decision point case, the student is required to select one/or more relevant answers to a multiple-choice question or perform the cloze procedure to proceed. The question itself is rooted in fundamental concepts and examines the pre-existing knowledge of the student. For instance, in

the electrical track, the student is prompted to solve a basic circuit analysis question by leveraging Ohm's law/Kirchhoff's law. Finally, the behavior-based decision case contributes toward the formulation of the individualized psychometric attribute tracking matrix. For instance, in the cybersecurity track, the culprit character that is caught by playing through the track and solving the application and assessment decisions is revealed to be a friend of the student's character. The student is then presented with a decision wherein they would have to evaluate their mutual history, character motivations, and severity of the hacking offense to choose whether to report the culprit, join the culprit, or condone the culprit. This branching narrative stemming from the player's decisions is purported to be confer a notion of completeness to the experience of the student. Each behavioral decision has certain values associated with it in terms of the sub-traits it addresses. It is worth mentioning that the values are not objectively set, but rather relative in the sense that certain decisions are evident of openness, while others are definitively indicative of neuroticism. In the case of complex decisions, the values for each trait are selected such that their combination sums to 1 (the maximum for any single trait), and the individual traits are assigned values relative to its saliency as compared to the other traits.

Furthermore, the three types of decision points bring three different advantages to the student experience on the platform. Application-based decisions can possibly trigger the hypercorrection effect, which is the phenomenon leading to errors committed with high confidence having greater recall when the true answers are revealed in a delayed manner (Butterfield and Metcalfe, 2001). Assessment-based decisions reinforce learning by utilizing the testing effect prevalent in traditional effective learning methodologies. It is theorized that the inclusion of a spaced repetition algorithm that can bring back certain questions in the assessment-based decisions can improve learning outcomes in the long run as well, but this has not implemented in this iteration (Greving and Richter, 2018). Behavior-based decisions are utilized to garner insights (albeit naively at the current state of the platform) about the psychological make-up pertaining to the student based on their interactions in the story narratives (Tamborini et al., 2018). All the technical questions are based on the quiz and exam material

used by the lecturers belonging to their respective taught courses. The behavior decisions are drafted with the aid of a psychologist and career counselor from the American University of Sharjah.

In the narrative and visualization module, the narrative situations are simplistic at the current stage, and have a similar flow as the structure outlined below:

- Student joins a new company or is called to respond to an emergency.
- Supervisor assigns student a task or student is supposed to resolve the emergency.
- Student navigates through the track through a series of decisions (application, assessment, and behavioral) which engages critical thinking, active recall, and personal intuitions.
- Student is presented with the organic conclusion of the current self-contained track with new tracks unlocked based on their performance and decisions in the current track.

The narratives are manually written by the authors, and the branching decision points are inspired by both fictional accounts and real-life industry experiences.

The AI, IoT, and electronic tracks have two characters, with the exception of the cybersecurity track where there are three characters. Each character sprite is animated with five basic emotions: joy, fear, sadness, disgust, and anger. Sentiment analysis of the description/dialogue in a single instance (small part of the full track) using the *Valence Aware Dictionary and sentiment Reasoner (VADER)* (Hutto and Gilbert, 2014) *approach* to attune a character(s) with a respective emotion and then render the particular spite on screen.

One of the future goals is to automate the narrative creation process in favor of random generation, with considerations of consistency with the track theme, similarity to existing stories, and comprehensibility in terms of logical flow. Open-source variants of GPT-3 can be made to artificially generate semi-realistic story scenarios wherein the decision points can be integrated through conditional training on the lecture material. However, the nature of the data available for this process would be a considerable bottleneck for the quality of the generated narratives, which brings to light the laborious

FIGURE 1 | Narrative Integrated Career Exploration (NICE) platform architecture.
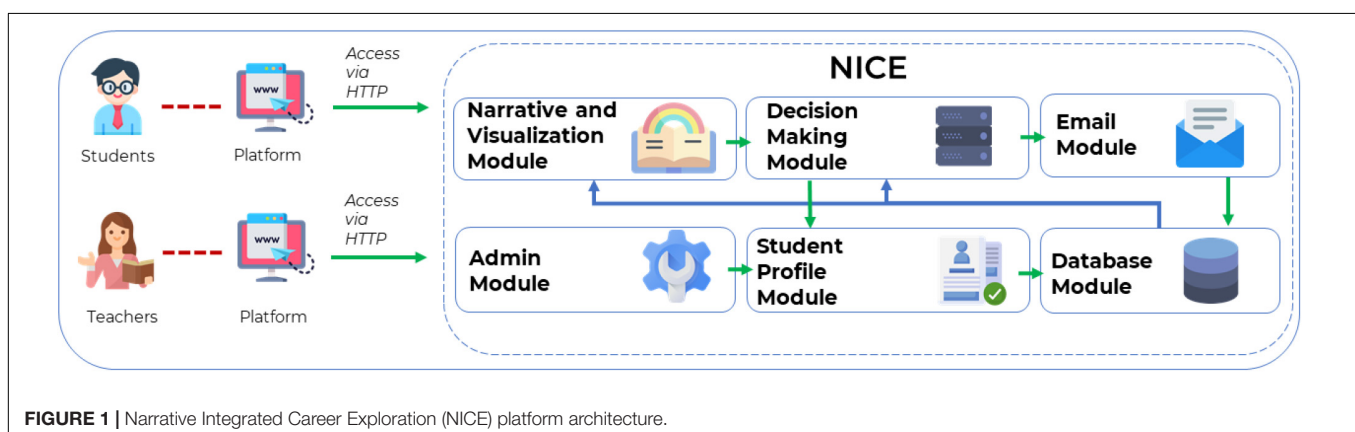
alternative of university-level volunteer crowdsourcing for internship experiences and short fiction.

Implementation

The proposed framework was implemented on a workstation with Windows OS, an AMD Processor with 3.1 GHz speed (Ryzen9-5900HX) and 16 GB of RAM. The Python (3.8) programming language was used for developing a Node + Express server to support the proposed framework. The cloud-based Google Firestore was used as the NoSQL database. The admin, email, and database modules are purely auxiliary implementation tools in the NICE framework. Google OAuth 2.0 login was employed to enable authentication. The user-interface of the platform was designed using the Ionic (3.0) and Angular 2 frameworks. The ngrok service was used to expose the running server to be accessed over the internet, and the waitress package allowed for production-level concurrency. The animated characters and effects were purchased from artists through creative art website dribble.io. Admin level users, such as instructors can create quizzes (decision points), write narrative scenarios, and order the track elements, select the branches for each decision, and choose an available character template. The VADER tool helps in selecting the right character-emotion pair, per story. The specified information is pushed to the database and is realized on the front-end of the platform. The student's login to the platform, select a track from the homepage, and follow its course.

Narrative Integrated Career Exploration Platform Evaluation

After the design of NICE platform, it was important to perform a real-life case study to determine the overall effectiveness of the application. In the first phase of testing, university students from various parts of the globe were invited to use the platform. Initial comments from the students were considered to improve the user interface, and narrative presentation of the platform. The next phase of testing planned would involve integrating the proposed application to high school and first year university CTE courses.

To empirically validate the interest and applicability of the platform with students, a case study incorporating the five-item Likert scale was designed. A Likert scale is a psychometric response scale to measure respondent agreement with the different statements probed (Likert, 1932). In this study, the available options on the Likert scale were (1) Strongly Disagree; (2) Disagree; (3) Neither Agree nor Disagree; (4) Agree; (5) Strong Agree.

RESULTS

Narrative Integrated Career Exploration Tracks

During the initial phase of development, four comprehensive career exploration tracks were deployed and tested. The

tracks are accessible online using the following webpage.[1] The implementation descriptions for each track are presented next.

Track A

In the narrative background of the artificial intelligence track, a healthcare facility needs to increase its patient screening rate for detecting COVID-19. As the physicians are burdened by the rising number of cases, the student in the role of a data scientist and an epidemiologist teams up to employ computer vision for the automated detection of infections in lungs using patient Computed Tomography (CT) scans, as displayed in the left of **Figure 2**. The objective of this track is to confer the understanding of an artificial intelligence development pipeline, and the rationale behind the selection of the various steps involved in data collection and artificial intelligence model deployment. The student can select one or more relevant steps in the process, and based on their selection, their developed model reports a certain performance measured by the diagnostic metrics of accuracy, sensitivity, and specificity, as shown in the right of **Figure 2**. The additional terminologies are slowly revealed to the student over the entire length of the track. The motivation behind this track is to expose interested users to the emerging field of artificial intelligence and its application to the ongoing COVID-19 crisis.

This track introduces the concepts of supervised computer vision, model evaluation, and data preparation. The main challenge is the track involves the student using knowledge conveyed about a medical condition, to set up an effective COVID-19 screening machine learning model. The student can select a lung CT scan dataset with different stratifications of patient demographics and observe the effect of model selection on final performance scores. The impact of removing redundant variables or missing values will be observed by the student at

[1]https://odysy-ai.web.app/

FIGURE 2 | Artificial intelligence showing narrative **(A)** and concept introduction **(B)**.
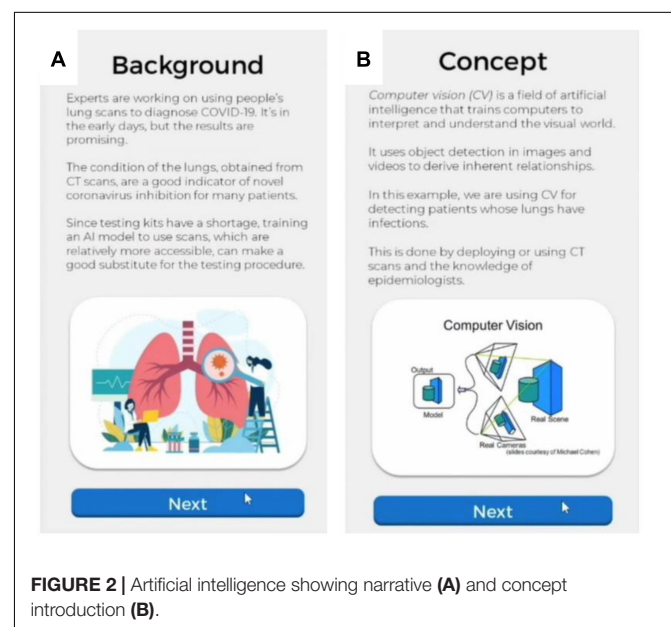
the end of the track only. The model evaluation criteria of sensitivity, specificity, positive predictive value, and negative predictive value are presented, and why they matter when making clinical decisions with certain models in terms of false positives, false negatives, and bias. Note that the students do not actually perform the live training of models in the track, but the tracks do indeed reflect actual training results conducted with regards to various research projects at the American University of Sharjah. Elements from the online data science training platform Kaggle (2022) were utilized as well, in order to better represent the nature of the challenge.

Track B

In the narrative background of the cybersecurity track, a computer in a business-critical location has been breached, and the student has to make the right decisions (technical and logistical) to circumvent the systems and make it secure again. The track is interspersed with story elements (sporadically offering hints) as shown in left of **Figure 3**. Moreover, decision or assessment points that test the understanding of the cybersecurity concepts or underlying basic networking and computing fundamentals are also part of the track, as shown in right of **Supplementary Figure 2**.

This track introduces the concepts of cybersecurity compliance, network protocols, terminal commands, and penetration testing tools on both Windows and UNIX systems. The main challenge is the track involves the student using knowledge conveyed about Common Vulnerabilities and Exposures, to examine system vulnerabilities and trace a hacker's identity by surveying IP addresses, MAC addresses, trojan viruses, and Operating System specific information. The student uses network mapping tools to find open ports, ping scan technique to find active computers connected their system and performs a basic patch for a vulnerability. Elements from the online cybersecurity training platform (TryHackMe, 2018) were utilized as well, in order to better represent the nature of the challenge.

Track C

This track introduces students to Internet-Of-Things. The student is given the role of an operations engineer whose task is to contribute toward the electric vehicle charging initiatives of a fictional town named Goldcoast. The objective of this track is to introduce the concepts of smart monitoring with sensors, device communication protocols, and configuration of a microcontroller-based system. A sample from this track is displayed in **Supplementary Figure 3**.

This track introduces the concepts of internet-of-things communication protocols, Bluetooth low energy, and sensors. The main challenge is the track involves the student using knowledge conveyed about embedded systems and requirements, to install a sensing module that detects motion for counting frequency of electric vehicle arrivals to a charging station. The student is presented with quality, durability, and cost considerations of purchasing smart devices, and they use knowledge about microcontrollers, and energy efficient computing to realize a stand-alone interconnected system. Finally, the student is required to think and address potential limitations of the project, and brainstorm improvements for scaling the system across many charging stations.
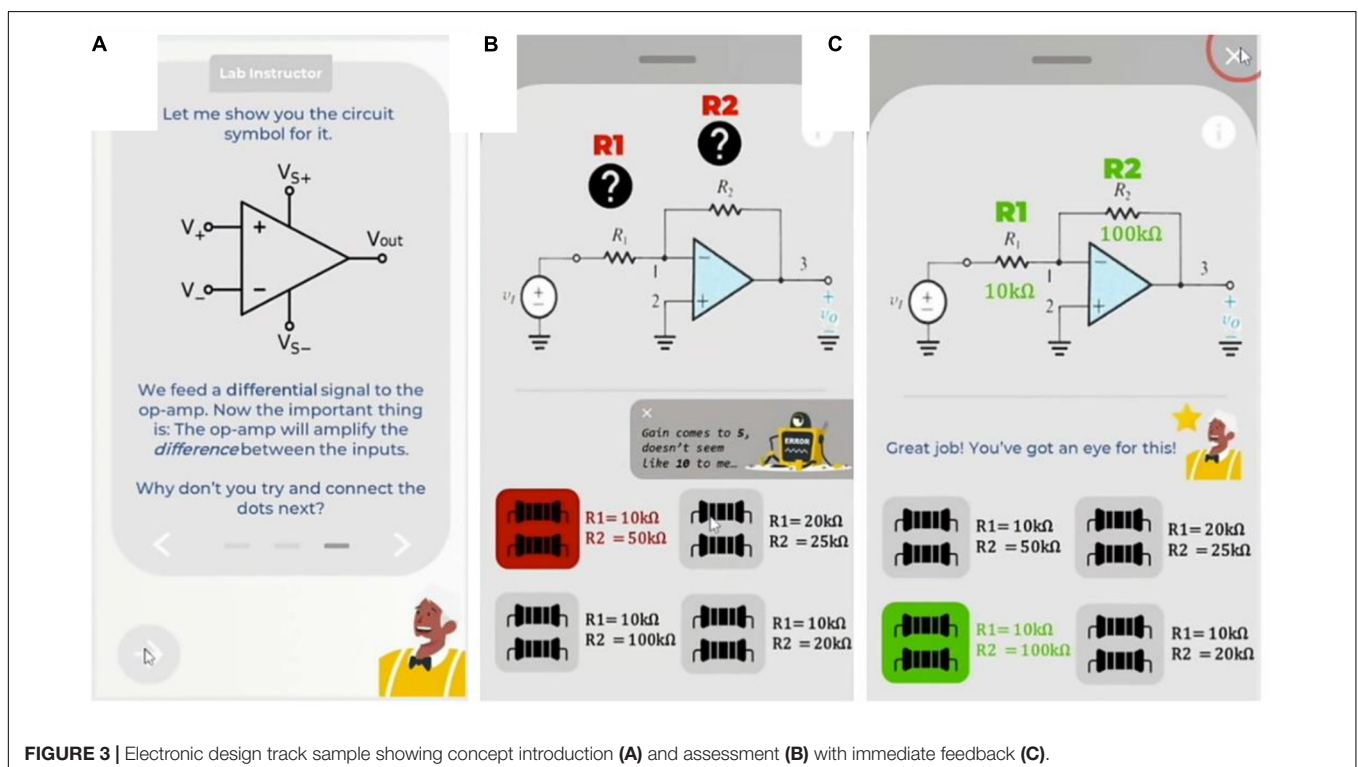

FIGURE 3 | Electronic design track sample showing concept introduction **(A)** and assessment **(B)** with immediate feedback **(C)**.

Track D

The final track in this phase is the electronic design track. The main character played by the student is a graduate student in a circuit design laboratory who has to deliver efficient circuits with the appropriate current, voltage, resistance, and power specifications to his supervisor. The basic concepts of electronic components are introduced and is followed by a series of assessments which progressively become challenging, as presented in **Figure 3**. Initially, the students must only select one component (i.e., resistors) at a time, while other variables are fixed. As they progress, they eventually must piece together a more complex circuit.

This track introduces the concepts of operational amplifiers, resistor combinations, open-loop gain, and input impedance. The main challenge is the track involves the student using knowledge conveyed about differential signals, to design a functional circuit that produces the desired level of gain. The student uses Ohm's Law, Kirchhoff's first and second laws, and basic understanding of voltages, currents, and resistances to develop this circuit. Finally, the student is required to verify the performance of the circuit in terms of gain, under varying external circuit requirements.

Kaggle and TryHackMe are generally used by individuals with a rudimentary understanding of the underlying principles yet integrating elements of the coding projected are intended to expose the layman student to the expanded scope of the field and show the bigger picture in a longer trajectory of learning.

Case Study Results

The duration of the study lasted 2 weeks, and the participants were recruited through an open call *via* email. Any student who had signed up for the American University of Sharjah's Fall 2021 enrollment inquiries mailing list within a 90-day period of May 2021–July 2021 (time of high-volume inquiries) was considered for inclusion. The students participating were not directly affiliated with the universities with this manuscript and were part of independent schools.

The study was asynchronously conducted as the students were not monitored live and had the freedom to perform the study tasks without supervision. The system tracked their decision points, time spent on each track from start to completion, and counted pauses as well. The students were instructed to do all four tracks, with the intention of selecting one or more of the four as their preferred career choice in this study. The intention was to only consider students at a pre-university, and late high school level. Out of 269 total students contacted, 145 responded to participate.

The study comprised of 145 participating students aged between 17 and 23. A student not being a currently registered university student was part of the exclusion criterion. Geographically, the volunteers were enrolled from universities in the United Arab Emirates, India, and the United States. Among the participants, all of them (100%) had prior exposure to educational technology enabled **supplementary tools** while either during school or university.

In the survey, the students were asked to answer three direct questions after completing the four tracks of AI Fundamentals,

Cybersecurity Essentials, Introduction to Internet-Of-Things, and Electronic Design, listed as follows:

- Question 1: Experiential career exploration like NICE can better help you make decisions about career choices and university programs.
- Question 2: NICE can reinforce your decisions even if you have already decided your career path.
- Question 3: NICE successfully introduced concepts of core science, technology, engineering, and mathematics (STEM) specializations in practical settings and made me interested in a new domain.

The responses of the students are summarized in **Table 1**. The results indicate successful conveyance of positive impressions by the platform.

DISCUSSION

The goal of the conducted study was to ascertain the perceived usefulness of similar platforms on the end-user student level for CTE. The rationale is that if students themselves are not motivated to willingly navigate through possible career tracks, then it is likely platforms such as this will be deemed as a chore.

TABLE 1 | Distribution of survey responses and average scores for the three direct questions.

Options	Respondents (%)
Question 1: Experiential career exploration like NICE can better help you make decisions about career choices and university programs.	
Strongly agree	66 (45.5%)
Agree	54 (37.2%)
Neither agree nor disagree	22 (15.2%)
Disagree	2 (1.4%)
Strongly disagree	1 (0.7%)
Score	**4.225**
Question 2: NICE can reinforce your decisions even if you have already decided your career path.	
Strongly agree	45 (31.0%)
Agree	76 (52.4%)
Neither agree nor disagree	17 (11.7%)
Disagree	6 (4.1%)
Strongly disagree	1 (0.7%)
Score	**4.089655172**
Question 3: NICE successfully introduced concepts of core STEM specializations in practical settings and made me interested in a new domain.	
Strongly agree	52 (35.9%)
Agree	63 (43.4%)
Neither agree nor disagree	24 (16.6%)
Disagree	3 (2.1%)
Strongly disagree	1 (0.7%)
Score	**4.075862069**

This can lead to students selecting random decisions, unaligned with their true personality traits, and general theoretical understanding, rendering the purpose of the project ineffective.

The survey responses can be ranked in order of their selection frequency: Agree, Strongly Agree, and Neither Agree nor Disagree. Majority of the students chose "Agree," which likely reflects their general interest and intrigue toward this novel style of career exploration and content delivery. However, a relatively lower number chose "Strongly Agree" possibly because while the platform appears promising, they are not aware of any long-term impacts on their knowledge, and they have not yet validated the advantages in terms of their own learning outcomes. Students who selected "Neither Agree or Disagree" probably did not find the mode of delivery any more enticing or informational than any systems they have previously interacted with. Fewer than 2% of the total respondents selected "Disagree" and "Strongly Disagree." It is possible that they may be accustomed to a more traditional approach of learning (i.e., rote memorization and classroom learning), and hence do not find value in the offerings of the proposed platform.

It is worth mentioning that the demographic of students who participated in our study had some level of prior experience with technology in education. This may skew the results with a positive bias when compared with students who have solely interacted with traditional pen and paper methods, Further development of the toolkit involves the addition of sub-specializations in the STEM field, with a focus on the conjunction of introductory concepts with practical applications in the same domain. The immediate next goal involves incorporation of this platform into student orientation and advising programs with the intention of enabling comparison with traditional systems. Finally, the long-term plan is to partner with entities who perform campus recruitments to allow them to showcase the nature of responsibilities and enable students to make informed decisions.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR CONTRIBUTIONS

JR: conceptualization, methodology, writing—original draft, and writing—review and editing. SS: conceptualization, data collection, writing—review and editing, and project administration. MT and TA: conceptualization, data collection, and writing—review and editing. AS and AA: writing—original draft, writing—review and editing, and supervision. All authors contributed to the article and approved the submitted version.

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Perception of Online Teaching and Learning (T&L) Activities Among Postgraduate Students in Faculty of Health Sciences, Universiti Kebangsaan Malaysia (UKM)

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The COVID-19 pandemic has changed the landscape of teaching pedagogies, assessment methods, supervision, and student engagement in higher education institutions. Exploration of students' perception on online teaching and learning (T&L) in terms of their level of satisfaction is an important core indicator of their acceptance to enhance the long-term impact of the online (T&L) activities. The objective of the study is to determine the level of satisfaction of online (T&L) activities and its involved technical support among postgraduate students in the Faculty of Health Sciences, Universiti Kebangsaan Malaysia (UKM). A validated questionnaire was used to conduct the survey. A total of 81 postgraduate students were recruited using purposive sampling in the study. Results showed that more than 86% of the students were satisfied with the online T&L activities except for two areas where 50% of the students felt that the curriculum structure design was too heavy and they felt stressed after attending the first online class and examination. On the other hand, more than 70% of the students were satisfied with the technical support for the online T&L. Although the satisfaction level for both was high, there was no association between them, χ^2 (1, $N = 162$) = 3.8, $p = 0.42$. In conclusion, the postgraduate students of the Faculty of Health Sciences, UKM are satisfied with the online T&L process, which implies a good reception. A review of curriculum structure and design that considers the psychological and behavior changes among students during online T&L is also recommended for the online T&L continues to be effective in the future.

Keywords: online teaching and learning, satisfaction level, student perception, postgraduate students, technical support

INTRODUCTION

The spread of newly emerged pathogen COVID-19 in December 2019 has caused nations around the world to impose total lockdown to curb the infection transmission among its population. Tourism, logistics, economics, media, and agriculture are one of the many sectors that was greatly affected by the pandemic surge. Besides medical and the local trading sector, the higher and lower

education sector in several countries including Malaysia has opted to open after the first lockdown to ensure the education supply chain was not interrupted continuously. The initial lockdowns had brought strict isolation measures which had delayed educational institutions across the globe from commencing with classes (Choi et al., 2021).

Due to the lockdown, educators from all around the globe had to change their teaching pedagogies overnight, which include teaching methods, mode of assessment, supervision technique, and student engagements among others to fully online distance learning (Lillejord et al., 2018; Langford and Damşa, 2020). This abrupt shift in teaching methods does not only cause tense to the educators in terms of sharing knowledge but also to the students who are on the receiving end as well. Both educators and students had to acclimatize swiftly to these changes to ensure the formal education process is not compromised. Virtual teaching and learning (T&L) *via* online or e-learning method that has been adopted to replace the conventional face-to-face teaching for the purpose of minimizing physical interactions and COVID-19 infection rate.

Prior to the COVID-19 pandemic, the integration of e-learning in higher education institutions was perceived as moderate, where the traditional face-to-face mode augmented with online materials was the most popular learning mode, followed by the blended learning (Nordin et al., 2011). The learning management system (LMS) or also known as the virtual learning environment (VLE) provided by respective institutions is the platform used by students mostly for the assessment (39.7%) and course management (39.1%) (Hamat et al., 2011). When LMS is not being used, content sharing tools such as Slideshare (45.3%), photograph or video sharing such as Youtube (37%), and social networking tools such as Facebook (36.8%) are used as alternatives (Hamat et al., 2011).

Availability and accessibility to internet connections is essential in enabling e-learning through web-based learning and switching from campus face-to-face learning to a distance education model. The renewed model can be implemented as a self-paced independent study, in real-time or asynchronous interactive sessions between students and teachers (Wasim et al., 2014). However, unstable network connection was found to be the major challenge for online T&L during the pandemic, especially for students from the remote areas (Mishra et al., 2020). The absence of devices or equipment such as desktop or laptop for online learning at home when mobile phones are not effective for online class participation is also experienced by students with low socioeconomic conditions (Mishra et al., 2020). A lack of access in the virtual environment was found even before the pandemic, where most students accessed their online courses from their hostel (71.4%), or computer laboratory (50.2%) using the campus wireless network. Less than half access their online courses from home (46.9%) (Nordin et al., 2011). Besides that, in the initial phase of the pandemic, most educators and students had trouble conversing subjects that was not designed for online delivery such as laboratory activities and practical classes. To overcome the challenge, educators resorted to video-based laboratories or virtual laboratories using simulation tools and virtual reality to allow remote participation (Gamage et al., 2020).

Although the COVID-19 pandemic appeared as uncommon catalyst for promoting e-learning, it is still unclear whether students are ready and willing to make greater use of online education to obtain high-quality learning and learning opportunities, which could totally change students' attitudes and impression, and subsequently the general themes of online education. After 2 years of surviving T&L in online mode, it is relevant to explore the perception of learners toward this matter in terms of their degree of adaptation and possible suggestions in improving the T&L activities (Bali and Liu, 2018). Therefore, the purpose of the current study is to explore the perception of online T&L among postgraduate students in Faculty of Health Sciences, Universiti Kebangsaan Malaysia (UKM).

MATERIALS AND METHODS

This was a cross-sectional study with purposive sampling method. The sample population was postgraduate students in the Faculty of Health Sciences, UKM, with admission year between February 2020–2021 and February 2021–2022. The inclusion criteria were all students who have completed the Statistics for Health Sciences and Research Methodology course by the faculty through online learning. Current students who were enrolled from October 2021 onward were excluded from the population sample size.

A validated self-administered questionnaire was adopted from Farooqi et al. (2021) to assess perception on online T&L among Faculty of Health Sciences, UKM postgraduate students. The questionnaire was shared through student's email and WhatsApp in November 2021 for 3 weeks using Microsoft forms. The questions were categorized based on the assessing satisfaction with online T&L and their technical support during the online T&L. The questionnaire included participant acknowledgments; 16 items that is to be rated at 4-point Likert scale (from 1–strongly disagree to 4 – strongly agree) (**Figures 1**, **2**).

Data acquired from the study were analyzed using SPSS. A descriptive method was used to measure the satisfaction level of online T&L activities and the satisfaction level of technical support of online T&L among postgraduate students in Faculty of Health Sciences, UKM. For descriptive statistics, percentages and bar graphs were created. Chi-square was used on the data to determine the association between technical support and level of satisfaction of online T&L activities among postgraduate students in Faculty of Health Sciences, UKM. The level of significance was set to be at 0.05.

RESULTS AND DISCUSSION

The online survey consisted of 16 questions, and the sample size was students from Ph.D, Master by Coursework and Master by Research program in Faculty of Health Sciences, UKM. A total 81 students responded and among which 23 (28%) were men and 58 (72%) were women. Totally, 23 Ph.D (28%), 45 Master by Research (56%), and 13 Master by Coursework (16%) students participated in the survey.

FIGURE 1 | Student's satisfaction with Online T&L activities.

FIGURE 2 | Student's satisfaction with technical support for online T&L.
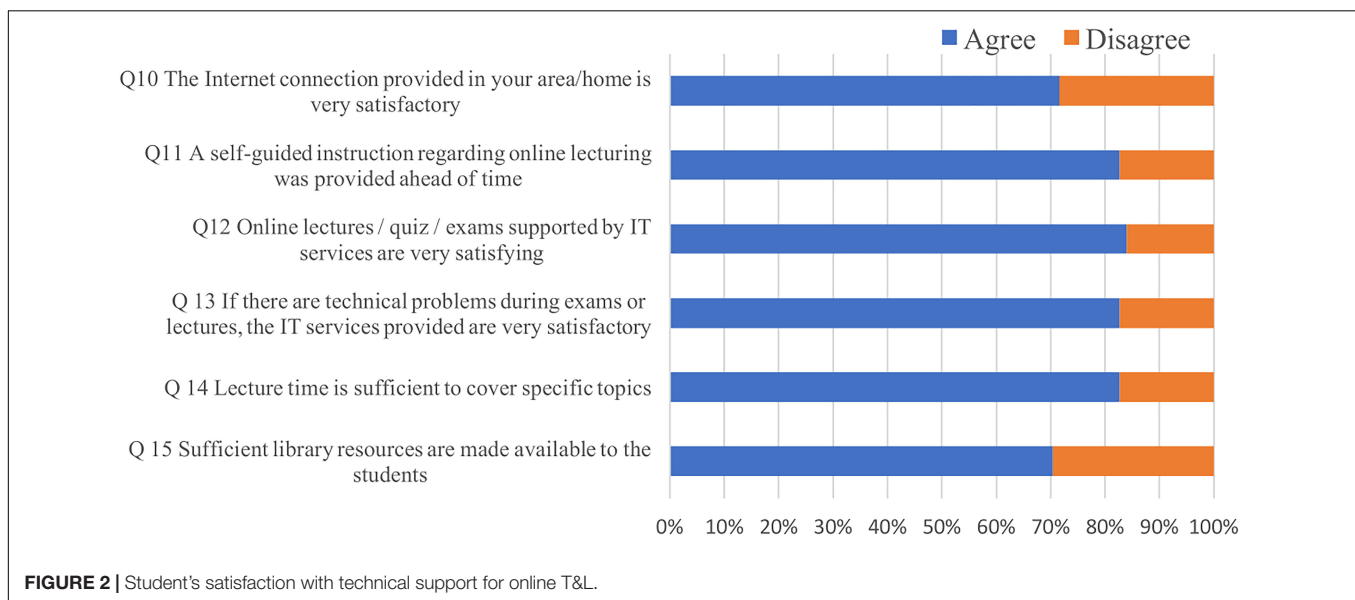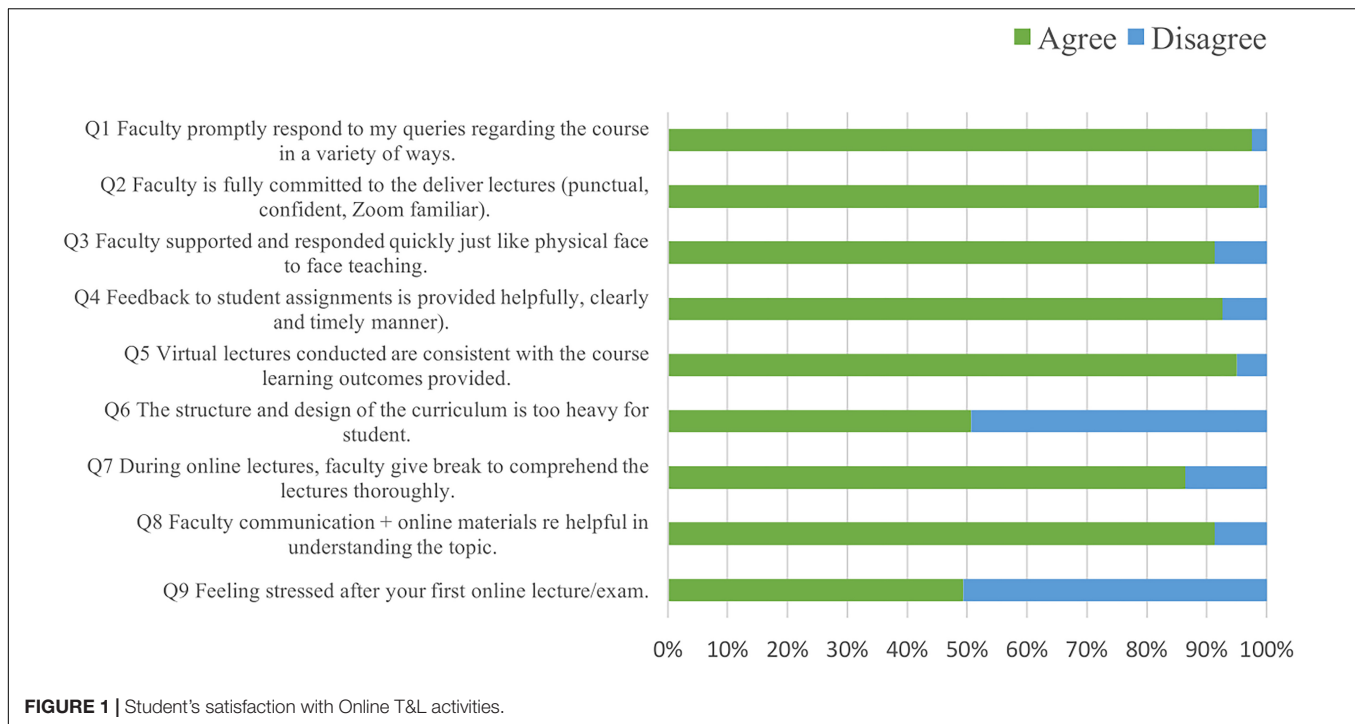
Students' satisfaction level with T&L activities showed that majority of the students (more than 86%) indicated that they were satisfied with the online T&L except for two areas. Totally, fifty percent (50%) of the students found that the structure and design of curriculum was too heavy, and they felt stressed after online lecture and examination (**Figure 1**). The findings denote that students' satisfaction with online T&L was at the higher level (more than 86%), which implies that the quality of T&L in the students' view in overall was good. These aspects of current findings were similar with a previous study done by Suarman et al. (2013) reporting that the students' satisfaction with the

online T&L was moderate (more than 80%). However, about 50% of them are hoping to receive better structure and design of the curriculum and not feeling stressed after their online examination such as current study. This might be because the curriculum structure is designed for offline delivery as opposed to online. For online courses, innovation of the curriculum should not only focus on students' key competencies, but also must attract students' motivation and learning interests, reflect the nature of interesting, comprehensive, and active course content, and should enhance students' engagement and communication (Li et al., 2021). Online learning was stressful for some students as

they might be studying in a completely different environment that was not prepared for education (Elshami et al., 2021).

On the other hand, students' satisfaction level showed more than 70% of respondents satisfied with the technical support, such as internet connections at home, IT services and trouble shooting for online lectures and tests, library resources, and instructions for online lectures (**Figure 2**). This denotes that overall, the postgraduate students had no problems with technical aspects during online T&L activities. Students expected to have adequate experience and better satisfaction in online classes when institutions provide sufficient online resources and technical support to enhance student–instructor interaction (Elshami et al., 2021).

Since the satisfaction level was found to be good for the online T&L activities and their involved technical support, association between the two was determined using chi-square test. Chi-square test was used to determine the association between online T&L and technical support. However, the association between these satisfaction level of online T&L and satisfaction level of technical support was found to be not significant, χ^2 (1, N = 162) = 3.8, p = 0.42. Satisfaction level of students with technical support does not influence the satisfaction level of the online T&L. They are independent of each other. This can be interpreted as satisfaction level with technical support does not define or support the satisfaction level of the online T&L. In another word, students might not be satisfied with the online T&L activities even though if they have a good technical support, or *vice versa*. This might be because technical support could be one of the small supporting factors that determines satisfaction level of students. They are many more factors such as instructors' factors, communication tools, and many more which also contributes to the satisfaction level (Bolliger and Wasilik, 2009).

CONCLUSION

The questionnaire in this study managed to assess the satisfaction level of online T&L activities and technical support among postgraduate student in Faculty of Health Sciences, UKM. In conclusion, results displayed that the postgraduate students were fairly satisfied with online T&L activities and their technical support, thus indicating a positive experience and acceptance of e-learning. A review of curriculum structure and design that considers the students' psychological well-being during online T&L is recommended for online T&L continues to be delivered effectively in the future.

Several limitations exist in this study. The use of closed-ended questions may not investigate various aspects of satisfaction in online T&L, particularly in relation to technical support, thus at

risk of losing important information. The reported satisfaction levels were also not representative of students across different programs. Future research that takes into account different demographic background as well as students' past experience with e-learning or training will help to identify other factors that may influence online T&L. Exploring educators' satisfaction with online T&L is also worthwhile as this will help gain a different perspective for improving e-learning in the future.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AG directed the research project and led the editing of this manuscript. EZ contributed to the questionnaire revision, graph development, and writing in Frontiers' format. IM was in charge of writing the literature on this topic and contributed to the data collection and revision of the questionnaire. LG led the execution of the research project, conducted SPSS analysis, and assisted in the data collection and questionnaire revision. NN was in charge of the analysis and interpretation of data and helped search for bibliographic information. RA also conducted SPSS analysis, helped in the literature search of the topic, assisted in the data collection, and supported the manuscript writing. SM contributed to the data collection, supported the wrote-up of the discussion, and the questionnaire revision. WT contributed to setting up the questionnaire and supported the literature review of the topic. All authors contributed to the article and approved the submitted version.

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Online Learning and Teaching Technology Services: USIM's Experience During COVID-19 Pandemic

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INTRODUCTION

COVID-19, a public health crisis of worldwide importance, was announced by the World Health Organization (WHO) in January 2020 as a new coronavirus disease outbreak and was reported as a pandemic in March 2020. Malaysia reported the first priest's death in Sarawak due to the virus on March 17. The increase in the number of cases to more than 500 cases by mid-March forced the government to make more rigid regulations.

The Coronavirus 2019 (COVID-19) pandemic has caused extraordinary challenges in the global education sector (Crawford et al., 2020). Most countries temporarily closed educational institutions in an attempt to contain the spread of the virus and reduce infections (Tria, 2020). Face-to-face education has ended by numerous schools, universities, and colleges. Educational agencies are trying to find alternative ways to manage this difficult circumstance (Dhawan, 2020).

In Malaysia, the move to online teaching and learning methods accelerated as a consequence of the physical closure of universities and university colleges on 1 April 2020. This shutdown stimulated the growth of online educational activities so that there would be no interruption to education. Many faculties have been involved in how best to offer online course material, involve students, and perform evaluations (Mukhtar et al., 2020). This crisis has forced everyone to adapt to the new technology used in all fields including education. Most educators had to change their approaches to most aspects of their work overnight: teaching, assessment, supervision, research, service, and engagement (Langford and Damşa, 2020; Sangster et al., 2020).

However, among the challenges faced by educators were because of infrastructure problems such as internet connectivity, students experienced distraction and reduced focus in learning online during the COVID-19 pandemic (Maqableh and Alia, 2021). These complications demonstrate students' level of readiness for online learning and have effects on online learning perception and course satisfaction (Wei and Chou, 2020).

Therefore, e-Learning allows students the opportunity to control the subject and arrangement of learning content, learning time rate, and media selection, which is allowing them to fulfill their needs to achieve personal learning objectives (Ruiz et al., 2006). In this study, the researcher focused on identifying the use of e-Learning and technology services among students and academicians of Universiti Sains Islam Malaysia (USIM).

LITERATURE REVIEW

e-Learning

e-Learning is a fast-growing flexible education form and a new style in delivering education in general. e-Learning has been described as a dynamic, innovative, and varied method in providing opportunities to acquire knowledge (Belcher and Vonderhaar, 2005). e-Learning is also referred to as web-based learning, online learning, directed learning, computer-assisted teaching, or Internet-based learning. Students can access classes through the website, LMS and participate in lectures or group discussions according to their schedule. According to Kaplan-Leiserson (2000), e-Learning is teaching and learning processes that use electronic networks (LAN, WAN, or Internet) to convey content, information and even interact through it. Meanwhile, the internet, intranets, satellites, audio-video tapes, interactive tv fans CD-ROMs are part of electronic media that is used to practice e-Learning. The revolution in the learning and application of computer education as well as the use of computers in education is still new and evolving day by day, and finally, the concept of technically guided e-Learning was introduced to supply educational knowledge to students in an effective way (Al-Mobaideen et al., 2012). According to Bertea (2009), some academics consider that e-Learning means any teaching process that integrates any form of technology, but some academics claim that e-Learning represents a teaching solution for distance education, facilitated by the maximum use of the internet as a form of communication. The acceptance of e-Learning is not only changing the traditional mode of learning, the cost of the program, and the online version, but the user can increase the level of teaching effectiveness, save costs and increase the level of student satisfaction in seeking knowledge.

e-Learning in Institutions of Higher Learning (IHLs)

In Malaysia, a study on the implementation of e-Learning in Institutions of Higher Learning (IHLs) was conducted in 2011 by Embi et al. Their study was to observe the status, trends, effectiveness, and challenges of e-Learning integration in teaching and learning in IHLs of Malaysia. The respondents in this research involved administrators, lecturers, and students who are using the e-Learning method. The results show that in general, 42.3% or 11 IHLs offer more than 50% of their courses online (Embi et al., 2011). Their results also show that the most popular e-Learning mode among the IHLs is the supplementary to face-to-face mode, followed by the blended learning model. For students, there are some challenges they face in e-Learning, such as the lack of access, lengthy response time from lecturers, lack of content, time-consuming, and uninteresting content compared to other applications such as Facebook (Embi et al., 2011). In iKlik website, states that e-Learning education is considered worthwhile and flexible, which is notes and tutorials are available from the Internet as well as online lectures. Indirectly, it can save cost and time especially for those who work full-time or live far from the university (Hazwani et al., 2017). The emergence of the development of educational technology that began with the use of personal computers in the early 1980s has influenced the teaching and learning process at all educational institutes. Over time, e-Learning is categorized as a model of lifelong learning, and even its presence is well-accepted among the global community. Society began to understand the importance of knowledge and information thus accepting the concept of e-Learning as a temporary learning model for the future (Asia e University, 2010).

e-Learning Is a Necessity During Pandemic COVID-19

The major part of the world, including Malaysia, has been quarantined due to this serious outbreak of the COVID-19 global pandemic and therefore many cities have turned into phantom cities and the effects can be seen in schools, colleges, and universities as well. The Corona Virus has made institutions go from offline mode to online mode of pedagogy. This crisis will make the institutions, which were earlier reluctant to change, accept modern technology. Institutions and organizations should prepare contingency plans to deal with challenges such as pandemics and natural disasters (Seville et al., 2012). Many universities around the world have fully digitized their operations in understanding the desperate needs of the current situation. Now, online learning is emerging as a very important platform in education around the world, including Malaysia.

Innovative solutions by institutions can only help us deal with this pandemic (Liguori and Winkler, 2020). Therefore, the quality enhancement of online teaching-learning is important at this stage. During these difficult times, the concern is not about whether online teaching-learning methods can provide quality education, but how academic institutions will be able to adopt online learning on a large scale (Carey, 2020). The findings of the current paper corroborate the findings of previous research on the same issues about online learning during COVID-19, and the results showed that students are not happy with distance education and many obstacles have been encountered (Bataineh et al., 2020; Rajab et al., 2020). According to research by Mahyoob (2020) about the general satisfaction of learners with online English language education during the COVID-19 crisis, the discussion found that in the beginning, most have lacked the experience and confidence to learn online using new mediums. After a while, most students could overcome most of the technical issues associated with online learning platforms. According to Weiser (2002), the process of teaching and learning can be more clear and interesting through video streaming methods. Besides, the web-based of teaching and learning methods is one of the mediums that can improve student learning level. Through this method, the learning and teaching process will be more smooth and efficient among students and lecturers. The web-based of learning methods also can help students complete a task given on time efficiently. According to Will Richardson (2010), teaching and learning methods by the online web will make a student being more positive and try to learn information literacy skills by using the internet. Moreover, the usage of this online web not only provides many benefits to the teaching and learning process, but it is also even can create good relationships between students and lecturers.

The Use of Technology Services in Education

Technology is perhaps the strongest factor shaping the educational landscape today (Johnson et al., 2016). The use of technology in education needs to be improved by educators especially in the delivery of information in the current learning system to students at universities. Many universities are showing support for increased levels of technology in the classroom by providing hardware such as computers, enhancing internet connectivity, and implementing programs designed to improve computer literacy for both teachers and students (Johnson et al., 2016). These requirements are important for us to adapt to the progress of this current era i.e. the digital era which is students nowadays tend to think more creatively and innovatively. According to Kern's (Kern, 2006) view technology serves as an intermediary between teachers and students. In addition, media technology is one of the intermediate mediums to convey information among each other. Kop's (Kop, 2011) study explains that one of the biggest contributions of internet technology in education is in terms of the dissemination of learning content without borders.

The use of social media has made the learning process is more interesting and productive. According to a study conducted by Kaplan and Haenlein (2010), social media is defined as a group of internet applications built on ideology and Web 2.0 technologies that allow the production and sharing of user-generated materials. We can see that at first, the use of Facebook as social media are only to get to know and communicate with each other, and now it has turned to educational purposes. According to (Beer, 2008) study, Facebook is the most popular social media among students and society. Through the Facebook site, lecturers and students can access information easily and faster especially information related to current issues, education, and learning.

The internet is very important in the use of e-Learning methods to facilitate educators and students to interact with each other online or deliver information widely. Rader and Wilhelm (2001) say that this method allows students to obtain the information desired in teaching and learning more systematically. In addition, video streaming is also a tool that is often used in the education system and is also known as a creative alternative in creating a teaching and learning environment which is more interesting and effective. According to Littlejohn (2003), the use of video streaming in the teaching and learning process gives a lot of benefits and goodness as it can be encouraging students to be more active, collaborative involvement and interaction between lecturers and students.

Research Objectives

The research was conducted to:

1. Identify the use of online learning among USIM students and academicians.
2. Identify the experience of USIM students and academicians in the use of teaching technology services.

TABLE 1 | Demographic.

	Frequency	Percentage (%)
Staff	91	20.9
Student	345	79.1
Total	436	100.0
Malaysian	428	98.2
Non-Malaysian	8	1.8
Total	436	100.0

TABLE 2 | Years of teaching experience.

	Frequency	Percentage
1–3 years	14	15.4
3–5 years	10	11
5–10 years	26	28.6
Above 10 years	41	45.1
Total	91	100.0

Research Methodology

This quantitative study involved 345 students and 91 staff from Universiti Sains Islam Malaysia who were selected randomly, which is deemed significant to provide useful feedback on both staff's and students' perceptions of online learning. The study used an online survey, which is delivered to participants in the period between September 17 and October 16, 2020. The online survey was created Google Forms and sent to the staff and students through emails, Telegram messages and Whatsapp messages.

The online survey consisting of three sections was used as an instrument to collect data. Section 1 contains demographic information of the students or staff. Section 2 was to identify the use of online learning among students and staff. Section 3 was to identify their experiences in using teaching technology services.

RESULTS AND DISCUSSION

Table 1 shows the demographic of the respondents. A total of 436 students and staff from all faculties have participated in the study. 20.9% (91) were staff while 79.1% (345) were students. 98.2% of the respondents were Malaysian while 1.8% were non-Malaysian.

Table 2 shows the total years of teaching experience among staff. The majority of the staff has above 10 years of teaching experience with 45.1%. Besides, 28.6% of 91 staff have 5–10 years of teaching experience. The minority or 11% of the staff has 3–5 years of experience. While the 15.4% staff has only 1–3 years of teaching experience.

Table 3 shows the years of studies among students who were participants in this research. The majority of 66.4% of the students are from year 1 (229). 14.8% from year 2 while 12.5% of the respondents were from year 3 students. This research has also been participated by year 4 and 5 students, which is 5.2% and 1.1%.

TABLE 3 | Years of studies.

	Frequency	Percentage
Year 1	229	66.4
Year 2	51	14.8
Year 3	43	12.5
Year 4	18	5.2
Year 5	4	1.1
Total	345	100.0

TABLE 4 | The rate of USIM staff skills in e-Learning.

	Frequency	Percentage
Fundamental Awareness (basic knowledge)	5	5.5
Novice (limited experience)	8	8.8
Intermediate (practical application)	60	65.9
Advanced (applied addition features/elements)	15	16.5
Expert (recognized authority)	3	3.3
Not Applicable	0	0
Total	91	100.0

TABLE 5 | The rate of USIM student skills in e-Learning.

	Frequency	Percentage
Fundamental Awareness (basic knowledge)	85	24.6
Novice (limited experience)	42	12.2
Intermediate (practical application)	140	40.6
Advanced (applied addition features/elements)	66	19.1
Expert (recognized authority)	10	2.9
Not Applicable	2	0.6
Total	345	100.0

TABLE 6 | The classification of the understanding of synchronous and asynchronous online learning mode among the staff.

	Frequency	Percentage
Fundamental Awareness (basic knowledge)	4	4.4
Novice (limited experience)	9	9.9
Intermediate (practical application)	59	64.8
Advanced (applied addition features/elements)	15	16.5
Expert (recognized authority)	4	4.4
Not Applicable	-	-
Total	91	100.1

TABLE 7 | The course that too challenging for students through online implementation.

	Frequency	Percentage
Not at all	38	11
Only one subject	14	4.1
A few subjects	238	69
Most of the subjects	45	13
All of the subjects	10	2.9
Total	345	100.0

Table 4 shows the rate of USIM staff skills in e-Learning. The majority of 65.9% of the staff are intermediate skills in using e-Learning (60). 16.5% have advanced skills. 8.8% of the staff are at the novice level which is they have limited experience in these skills while 5.5% are at fundamental awareness level (basic knowledge). The minority group is at the expert level, which is only 3.3% of respondents. No staff is not applicable in e-Learning skills.

Table 5 shows the rate of USIM student skills in e-Learning. The majority of 40.6% of the students have intermedia (140). 19.1% have advanced skills. 12.2% of the students are at the novice level which is they have limited experience in these skills while 24.6% are at the fundamental awareness level (basic knowledge). The Students who are experts in e-Learning skills are 2.9% of respondents. Lastly, the minority group who are not applicable in e-Learning skills which are only 0.6% of respondents.

Table 6 shows the classification of the understanding of synchronous and asynchronous online learning modes among the staff. The majority of 64.8% of the staff are at an intermediate level about this understanding (59). 16.5% of the respondents are advanced in understanding online learning mode while 9.9% of the staff are in the novice group. Lastly, both fundamental awareness and the expert group have the same results, which is 4.4% of the respondents.

Table 7 shows the course that the majority of the respondents i.e. 69% agreed that there are only a few subjects that are very challenging through online implementation. Thirteen percent of the respondents thought that most of the subjects were very challenging for them while only 11% stated that there were no challenging subjects to implement online. 4.1% stated only one subject was challenging for them. Lastly, only a minority group i.e. 2.9% of the respondents thought that all subjects were very challenging for them.

Table 8 shows the communication tools used by staff live conferences in synchronous mode. The majority of respondents use Microsoft Teams for live conferences which are 94.5%. Followed by the Zoom Meeting platform which is 54.9% while via Whatsapp video call is 38.5%. Based on the results, Instagram lives, StreamYard, Rooms, and Webex were the least used platforms by respondents at only 1.1%.

Table 9 shows that laptops are the most frequent personal devices used by students (93.9%) to support teaching and learning. Next, followed by the smartphone which is 93.6%. Desktop usage among respondents was 10.4% while the tablet was 9.6%. Only 0.3% of respondents use devices as mentioned in this questionnaire.

Table 10 shows the frequency of use of learning space among the students. The results show that the majority of respondents do not use the learning space which is 44.1% (152). Then followed by the use of 1–2 times a week by respondents which is 27%. 15.1%

TABLE 8 | A communication tools used by staff for live conferences in synchronous mode.

	Frequency	Percentage
Microsoft Teams	86	94.5
Skype for Business	10	11
Zoom Meeting	50	54.9
Google Meet	24	26.4
FB Live	10	11
YouTube Live	2	2.2
Live Podcast	0	0
WhatsApp Video Call	35	38.5
Telegram	22	24.2
Instagram Live	1	1.1
StreamYard	1	1.1
WhatsApp	4	4.4
Rooms, Webex	1	1.1
Webex	1	1.1
Total	247	

TABLE 9 | Personal devices to support teaching and learning among the students.

	Frequency	Percentage
Desktop (PC)	36	10.4
Laptop	324	93.9
Smartphone	323	93.6
Tablet	33	9.6
None of the above	1	0.3
Total	717	

TABLE 10 | Frequency of usage the learning space among the students (Before COVID-19 pandemic).

	Frequency	Percentage
1–2 times a week	93	27
3–4 times a week	52	15.1
More than 4 times a week	48	13.9
Not applicable	152	44.1
Total	345	100.0

TABLE 11 | Frequency of usage of the computer lab among the staff. (Before COVID-19 pandemic).

	Frequency	Percentage
1–2 times a week	19	20.9
3–4 times a week	2	2.2
More than 4 times a week	5	5.5
Not applicable	65	71.4
Total	91	100.0

TABLE 12 | Frequency of usage of the computer lab among the students (Before COVID-19 pandemic).

	Frequency	Percentage
1–2 times a week	140	40.6
3–4 times a week	42	12.2
More than 4 times a week	39	11.3
Not applicable	124	35.9
Total	345	100.0

TABLE 13 | Access to software that staff know.

	Frequency	Percentage
USIM VDI Portal	17	18.7
Microsoft Azure	4	4.4
Autodesk Education	6	6.6
Not Applicable	68	74.7
Total	95	

TABLE 14 | Access to software that students know.

	Frequency	Percentage
USIM VDI Portal	70	20.3
Microsoft Azure	13	3.8
Autodesk Education	29	8.4
Not Applicable	256	74.2
Total	368	

use it 3–4 times a week while 13.9% of the respondents use it more than 4 times a week.

Table 11 shows the frequency of use of computer lab among the staff. The results show that the majority of respondents do not use the computer lab which is 71.4% (65). Then followed by the use of 1–2 times a week by respondents which is 20.9%. 2.2% use it 3–4 times a week while 5.5% of the respondents use it more than 4 times a week.

Table 12 shows the frequency of use of computer lab among the students. The results show that the majority of respondents use the computer lab 1–2 times a week which is 40.6% (140). 12.2% of respondents use the computer lab 3–4 times a week

while 11.3% of them are using it more than 4 times a week. Finally, 124 respondents which is 35.9% do not the computer lab.

Table 13 shows data related to staff knowledge in accessing software. 18.7% of respondents are using USIM VDI Portal. 6.6% of them were using Autodesk Education while only 4.4% were using Microsoft Azure. The majority of respondents do not use all three software, which is 74.7%.

Table 14 shows data related to staff knowledge in accessing software. 20.3% of respondents are using USIM VDI Portal. 8.4% of them were using Autodesk Education while only 3.8% were using Microsoft Azure. The majority of respondents do not use all three software, which is 74.2%.

DISCUSSION

e-Learning is not considered a new phenomenon as it has long been introduced. However, not all education institutes use this method as the main medium in teaching and learning. This is because the e-Learning method is quite difficult for a few subjects that need face-to-face practical training such as experimenting in the lab. From the results, we can see that majority of the respondents were agreed that there are a few subjects that are very challenging for them to learn through online implementation. However, the current covid-19 pandemic crisis has forced all educational institutions to normalize e-Learning in their teaching and learning process. Bhuasiri et al. (2012) from their study were agreed that there was an increasing global trend of using electronic learning or e-Learning in the last decade and some higher education institutes in developing countries have adopted this trend recently. However, this technology has not been evenly dispersed throughout all nations and cultures (Hodgkinson-Williams et al., 2008). In such a time, the role of teachers is important to provide complete learning materials and increase the use of technology services in learning implementation. The medium or tools chosen should be appropriate and synchronous with the students so that no students are left behind. Therefore, students and educators need to improve their e-Learning skills well so that the learning process be implemented smoothly even online. The results of the study found that the level of mastery of e-Learning skills among the students and staff is at an intermediate level.

Personal devices played a vital role in supporting teaching and learning. Din et al. (2013) suggest that tablet computers allow greater mobility and flexibility in teaching and learning activities. These tablets and smartphones aren't the most powerful gadgets, but they are the most convenient and fresh in education.

Moreover, technology services can improve the teaching and learning process and enhance students' performance as well as course attaintment. Nevertheless, these technology services affected students' behavior to adapt or to leave them (Abdul Ghani et al., 2019). Providing free internet packages to B40 students definitely can solve the internet connectivity issue to ensure achievable learning modalities.

CONCLUSION

In this study, the majority of students and staff are at an intermediate level in e-Learning skills. This is because, they are still trying to adapt to this new phenomenon, where the COVID-19 pandemic enforced the entire world to rely on technology for education. However, the majority of students have shown their readiness for the implementation of e-Learning where most of them already have personal devices such as laptops and smartphones for the learning process. However, students still need to improve their skills in using technology so that they do not be left behind and be able to adapt to the new educational norms in this pandemic era. This study highlights the USIM's students and staff experience of e-Learning as a tool for teaching and learning within the education field, in developing countries and may lead to strategic development and implementation of e-Learning and view technology as a positive step toward evolution and change.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

MJ, MFA, and MC wrote the first draft of the article. NM, MHA, and NA contributed to the writing and editing of the manuscript. All authors contributed to the editing of the final manuscript.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.813679/full#supplementary-material

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Strengths and Weaknesses of Emergency Remote Teaching in Higher Education From the Students' Perspective: The Portuguese Case

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Motivated by the COVID-19 pandemic, most students of higher education institutions (HEIs) in Portugal experienced online learning from March 2020 to July 2020. Based on the answers obtained from students to a set of two open questions included in a questionnaire, this article aims to identify the positive (strengths) and negative (weaknesses) aspects of online learning during this period, which is also known as emergency remote teaching (ERT). A total of 2,107 valid answers were gathered. Issues related to comfort and time management were the topics most frequently mentioned by students as strengths, particularly for those who are simultaneously workers. In contrast, the assessments, interaction, and self-confidence comprised the set of the most frequently mentioned by students as weaknesses. In this latter context, the most evident differences were found by age, type of course, and students' status. The breakdown by gender did not show any relevant difference, regardless of the item under analysis. These findings may be useful for decision-makers to plan their actions, particularly regarding the new challenges for the future of higher education programs. Those actions may include the options regarding the most proper learning model among face-to-face, online, or blended learning by case, as well as the measures to improve the overall quality of the online learning to increase the students' satisfaction.

Keywords: emergency remote teaching, higher education, online learning, strengths, weaknesses, students' perspective

INTRODUCTION

The COVID-19 pandemic led to a general lockdown in several countries which responded in different ways to the challenge of maintaining the continuity of learning (Vincent-Lancrin et al., 2022). In Portugal, the higher education institutions (HEIs) abruptly moved from face-to-face to online classes from March to July of 2020. This period, which has impacted students from all over the world, was also called emergency remote teaching (ERT) since all the actors, including students and teachers, had no alternative or time for preparation (Gillis and Krull, 2020; Sason et al., 2022).

Then, teachers and students had to rapidly adapt to the methods that they were not used to, and for which some of them did not have the proper skills, nor the proper conditions. According to the study by Iglesias-Pradas et al. (2021), for classes and assessments, teachers used the tools and methods that they already knew, with no time to choose the most appropriate for each situation.

For instance, video conferencing platforms and institutional learning management systems (LMS) were commonly used tools during the lockdown (Chaka, 2020).

The literature on the ERT covers several countries, such as the United States (Parker et al., 2021), Hungary (Ismaili, 2021), Switzerland (Cacault et al., 2021), Portugal (Gonçalves et al., 2020; Flores et al., 2021), or China (Huang et al., 2020), including also multi-countries studies (Aristovnik et al., 2020; Marinoni et al., 2020; Ozfidan et al., 2021). Most of them collected data from a questionnaire (Aristovnik et al., 2020; Gillis and Krull, 2020; Gonçalves et al., 2020; Flores et al., 2021; Hensley et al., 2021), although some complemented the survey with interviews (as Parker et al., 2021).

Although being disruptive and unplanned, students rated some positive aspects or strengths of ERT. The main ones are the time and location flexibility, and health security (Gonçalves et al., 2020; Ismaili, 2021; Ozfidan et al., 2021; Parker et al., 2021). The class time flexibility and being able to assist classes everywhere are key features that distinguish online classes from face-to-face ones. For example, being at home was not only convenient but also safer during the COVID-19 pandemic and cheaper (especially for those who lived far from school).

Students also stressed teacher engagement as a strength of the online learning experience (Flores et al., 2021; Parker et al., 2021), as it is an essential element in the learning process. According to the study by Sason et al. (2022), during emergency times, students have significantly higher expectations of the teachers' technical and affective roles. Although recognizing the importance of self-motivation, and the individual learning approach, students valued the interaction and discussions as important attributes of online classes to motivate them to learn (Ozfidan et al., 2021), pointing out the importance of pedagogical practices, such as the teachers' support, the quality of the materials provided, and the quality of interactions (Flores et al., 2021).

Students also highlighted the need for social interaction. Then, the presence of a teacher in synchronous classes provided this element as if students were in the classroom, which was helpful in a period of isolation and social distancing (Dewsbury and Mermin, 2021; Nguyen et al., 2021; Todri et al., 2021). Aligned with this, Gonçalves et al. (2020) found that most of the students stressed that the use of conferences (e.g., video and audio) in synchronous classes facilitates the online learning process. Students also considered synchronous classes more engaging and motivating, allowing an easier interaction (Serhan, 2020; Dewsbury and Mermin, 2021). Therefore, and despite rating asynchronous techniques as very accessible and useful, students do not consider them as enjoyable as synchronous ones (Gillis and Krull, 2020).

The need for social interaction may also explain why students prefer face-to-face classes to online ones (Elfirdoussi et al., 2020; Lassoued et al., 2020; Cacault et al., 2021; Ismaili, 2021) since students rate the lack of face-to-face interaction and the absence of traditional classroom socialization as negative aspects of online classes (Gonçalves et al., 2020; Muhammad and Kainat, 2020). For instance, when being able to choose, most students at a public Swiss university preferred face-to-face lectures rather than online classes, which were used only occasionally, namely when it was too "costly" to attend the classes in person (e.g., in sickness cases and bad weather days) (Cacault et al., 2021).

Regarding the negative aspects or weaknesses of ERT, students showed concerns about the quality of their online education and the impact of the pandemic on their ability to learn and on their grades (Pettigrew and Howes, 2022). Flores et al. (2021) pointed out that students generally consider assessments as a negative factor in online learning, as they are more difficult, unfair, and more susceptible to fraud. According to the study by Maraqa et al. (2021), the nature and methodology of online assessments influenced the student perception as regards remote learning.

Other common weaknesses stressed by students when facing online classes are their disengagement, lack of concentration, and time management, due to the excessive number of homework (Hensley et al., 2021; Ozfidan et al., 2021; Parker et al., 2021). In addition, the criticism related to the unsuitability of the course contents in an online learning environment, particularly in what concerns laboratory and practical classes (Gonçalves et al., 2020; Parker et al., 2021), is also the reason behind the students' preference for face-to-face learning.

As technical infrastructure is a prerequisite for ensuring adequate distance learning, either from the HEIs or the students, this is a further element stressed by the literature as of the most important to a successful students' adaptation to online education, and commonly appointed as a weakness aspect of the ERT given the lack of basic issues, which directly impacted the classes quality and effectiveness, such as equipment (e.g., computers, laptops, or tablets) and reliable Internet (Coman et al., 2020; Favale et al., 2020; Gonçalves et al., 2020; Huang et al., 2020; Liguori and Winkler, 2020; Marinoni et al., 2020; Flores et al., 2021; Maraqa et al., 2021; Ozfidan et al., 2021; Treve, 2021; Zalat et al., 2021). The World Bank (2020) identified these as infrastructure challenges faced by the HEIs and students in the online learning process. Regarding the necessary conditions to have online classes, the lack of a suitable workspace is also pointed out by students as limiting their learning ability (Gillis and Krull, 2020; Maraqa et al., 2021).

Regarding the influence of sociodemographic characteristics, the literature is not conclusive in what concerns to the gender. According to the studies by Aristovnik et al. (2020) and Warfvinge et al. (2021), male students were more negative toward the online learning experience, whereas female students felt significantly better at coping with the transition. Bisht et al. (2020) also concluded that female students were keener to adopt online education in terms of assignments, study patterns, and comfort. However, Maraqa et al. (2021) found that male students were more inclined to online learning than female students, and Flores et al. (2021) did not find significant differences in gender concerning the adaptation to online learning among Portuguese high students. Concerning other sociodemographic factors, according to the study by Todri et al. (2021), the distance learning experience is more appropriate for those who have a job, and according to the study by Aristovnik et al. (2020), the applied sciences students (being a more practical course) are the ones significantly unsatisfied with ERT.

Given the specificity and atypicality of this ERT, it is relevant to identify the students' perceptions of it. Therefore, this article aims

to identify the positive (strengths) and negative (weaknesses) aspects of the online learning experience in Portuguese HEIs. The findings from this research may be useful for decision-makers to plan their actions, particularly regarding the new challenges for the future of higher education programs. Those actions may include the options regarding the most proper learning model among face-to-face, online, or blended learning by case, as well as the measures to improve the overall quality of the online learning to increase the students' satisfaction.

This article is structured into three sections besides this introduction. The "Materials and Methods" section supports the findings. Then, the "Results" section presents the results, and the "Discussion" section provides the limitations and avenues for future research.

MATERIALS AND METHODS

This section is divided into three subsections. The first section provides the information on the sample collection, the second section describes the variables, and, finally, the third section presents the method used for data assessment.

Sample Collection

This study aims to identify the positive (strengths) and negative (weaknesses) aspects of the online learning experience in HEIs in Portugal, which was motivated by the COVID-19 pandemic.

After the first lockdown, most students of HEIs in Portugal experienced online learning from March 2020 to July 2020. Then, the analysis is based on the students' answers to a set of two open questions, included in a questionnaire, covering this period. In the light of the literature review, the questionnaires constitute the main source of data collection for studies in this line of research (Aristovnik et al., 2020; Gillis and Krull, 2020; Gonçalves et al., 2020; Flores et al., 2021; Hensley et al., 2021).

The questionnaire, which was administered online through Google Forms, was distributed in July 2020 among the students of different courses and HEIs in Portugal who took synchronous and asynchronous online classes and online assessments. For this purpose, an invitation was sent by e-mail to several departments of HEIs, asking them to make it available to students. The participation was entirely voluntary and free.

At the end of the process, 2,107 valid answers from those students were gathered. Based on the study by Fávero and Belfiore (2017), and considering the reference population, the sampling error of the study is less than 5% with a confidence level of 95%. Based on the students' answers, 69% are female students, 58% are 25 years or younger, 27% are from practical courses, and 33% are also workers. Finally, most of the students (88%) have their personal computers to attend the online classes. The next subsection provides details on these demographic variables, which will be used for a more detailed analysis of the collected data.

Despite the abovementioned figures, the answers were attributed, in some cases, to more than one of the items of strengths or weaknesses proposed, as the answers indicated different topics. Then, some slight differences concerning those

figures can arise from this double-counting process. In contrast, it should be taken into account that the students' opinion on the strengths and weaknesses was not mandatory, in an effort to obtain a voluntary option on these issues. For this reason, missing values are also possible. Notwithstanding, those cases were also counted (one time) to capture the level of students who had no strong opinion on the positive (strengths) and negative (weaknesses) aspects of the online learning experience in HEIs in Portugal. The next subsection provides further details on the options taken for analysis purposes.

Variable Description

To obtain the students' perspective on the positive (strengths) and negative (weaknesses) aspects of the online learning experience, answers were assessed and classified into different items. Missing answers, as well as answers that indicated "none," "all," and similar were also classified. This classification is provided for both categories of strengths and weaknesses proposed.

The items were created to the extent that the answers pointed out a new element of analysis that could be individually classified for analysis purposes, also considering the similarities of the answers and perspectives regarding a certain aspect. Keywords were then used as an auxiliary process to classify the answers. Notwithstanding, each answer had to be individually read, given that, sometimes, the sense of the answer pointed out a different classification, even when students used similar words. For this reason, some keywords appeared in different items, depending on the overall context.

The objective of the classification proposed was to provide a quantitative analysis from the qualitative aspects mentioned by students on the strengths and weaknesses regarding their online learning experience. At the end of this process, with advances and setbacks to assure that different answers were related to a similar aspect, the following items were gathered as a relevant matter of analysis, as provided in **Table 1**.

To facilitate the comparison, the items proposed to the strengths and weaknesses analysis have the same numbering despite the different perspectives. However, items 8 and 9 were observed as non-applicable to the weaknesses analysis, being exclusively identified to the strengths analysis. In contrast, items 4 and 5 were exclusively identified to the weaknesses analysis.

Furthermore, there is an inherent constraint related to this type of analysis from its subjectivity. For instance, it is difficult to distinguish if a criticism of the classes or professors should be attributable to item 1 or 13, given that the pedagogical method proposed by a given professor could be explained by his/her non-adaptation to online classes. Then, and to avoid a higher level of researcher bias, those cases were classified within item 1 whenever it was not specifically mentioned the issues related to item 13. The same applies to other items, such as the one related to the online assessments (item 11), where the students' criticism could be associated with a low level of professors' adaptation to online learning overall.

The first part of the questionnaire included demographic variables relating to gender ($V1$), age ($V2$), course ($V3$), the students' status ($V4$), and students' condition (devices available) ($V5$).

Item	Some related keywords
0—Missing	Not applicable
1—Pedagogical quality	Availability; capacity; classes; feedback; learning; organization; pedagogy; professors; quality; support; teachers; teaching
2—Asynchronous online classes	Asynchronous; classes; record
3—Moodle, files, and other resources	Documents; contents; files; Moodle; materials; means; resources; tools
4—Internet issues	Internet; break; access; connection; fail; speed
5—Other infrastructures	Computers; devices; softwares
6—Comfort and timing management	Access; convenience; comfort; home; management; timing; transport
7—Autonomy, self-motivation, and learning process	Autonomy; independence; self-motivation; self-responsibility; organization; learning; management
8—Saving	Costs; home; money; rent; resources; transportations; savings
9—Health security	COVID-19; health; pandemic; safety; SARS-Cov-2; security; virus
10—Attention and concentration	Attention; noise; concentration; conversation; silence; disturbance
11—Assessments	Assessments; exams; grades; Moodle; quizzes; tests
12—Adaptation to online learning	Adaptation; efforts; innovation; resilience; technology
13—Interaction and self-confidence	Interaction; intervention; mutual help; participation; relationships; support; self-confidence
14—Others (general issues), as a residual category	
15—None/I don't know/I have no opinion	
16—All	

The objective behind the $V3$, despite the subjectivity of the classification proposed, is to find a different pattern of perspective concerning the need for more practical classes, which is attributed to courses, such as engineering, medicines and laboratory practices, information systems and similar, and arts (e.g., dance, music, cinema, and theater) in comparison with courses, such as management, accounting, finance, marketing, international trading, public relations, history, and other social sciences in general. Furthermore, the V5 has the objective to compare possible differences in students' perspectives concerning the existence, or not, of a proper condition to attend the online classes.

Analysis Method

As this article addresses two open questions, exploratory analysis is proposed (based on Hensley et al., 2021). Despite that, a significant effort was developed for converting the qualitative information into quantitative data, as explained in the previous subsection. Through this process, frequency analysis (in absolute and in relative terms) enables the development of a more comprehensive perspective.

Then, and in addition to the answers computed for the total, the results will be assessed through comparisons between two main subgroups identified within each of the demographic variables described earlier, as follows:

- gender ($V1$): men (codified as "M") vs. women (codified as "F");
- age ($V2$): 25 years or younger (codified as "$\leq$ 25") vs. older than 25 years (codified as "$>$ 25");
- course ($V3$): more theoretical courses (codified as "T") vs. more practical courses (codified as "P");
- students' status ($V4$): worker (codified as "W") vs. non-worker (codified as "NW");

Variable	Classifications proposed
Gender (**V1**)	Female (F)
	Male (M)
Age (**V2**)	Older than 25 years old ($>$ 25)
	25 years old or younger ($\leq$ 25)
Course (**V3**)	More practical courses (P)
	More theoretical courses (T)
Students' status (**V4**)	Non-worker (NW)
	Worker (W)
Students' condition (devices available) (**V5**)	Shared computer or non-proper devices, such as mobile phones (SC)
	Non-shared computer (NSC)

- students' condition (devices available) ($V5$): non-shared computer (codified as "NSC") vs. shared computer or non-proper devices, such as mobile phones (codified as "SC").

Table 2 presents the demographic variables studied and the classifications proposed.

The next section is dedicated to present the results considering the methodology proposed in this study.

RESULTS

This section presents the findings from the analysis of the strengths and weaknesses mentioned by the students in the questionnaire. **Figure 1** summarizes the relative frequencies of each item proposed.

From **Figure 1**, it can be observed a higher level of missing values (item 0) for the strengths (39%, which may be compared with 33% for the weakness), which indicates that the student's voluntary participation had a 61% level. From this

FIGURE 1 | Strengths (S) and weaknesses (W) from the students' perspective, in percentage.
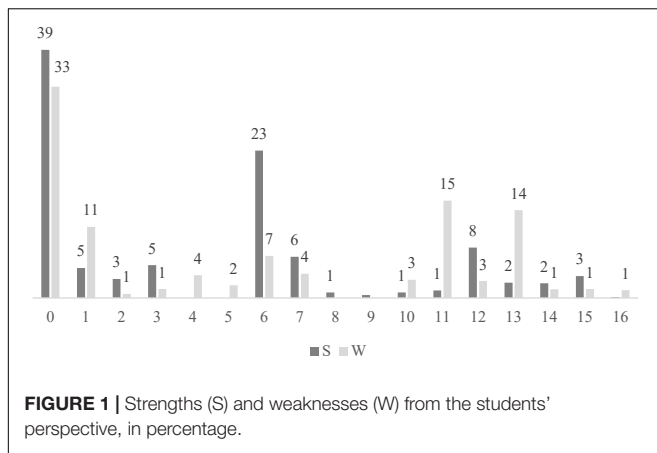
perspective, the level of students' participation (non-missing values) is two-third (67%) in the context of the weakness items, which means that students pointed out weaknesses more frequently than strengths.

It can also be seen for the strengths, as the most frequently mentioned item, the item "6. Comfort and timing management," with 23% of all cases (only 7% for the weaknesses). With percentages between 5 and 8%, the following items arise in the context of the strengths: "1. Pedagogical quality" and "3. Moodle, files, and other resources," with 5% in both cases, "7. Autonomy, self-motivation, and learning process" (6%), and "12. Adaptation to online learning" (8%). Therefore, it may be stressed a relevant difference (15 percentage points) between the most frequent and all other aspects mentioned by students concerning the strengths regarding their online learning experience.

In contrast, the highest level of a given weakness item is 15%, which can be found for item "11. Assessments," which is close to the 14% level found for item "13. Interaction and self-confidence." It is worthwhile to mention that these two aspects had low frequencies in the context of the strengths (1 and 2%, respectively). Following, it arises the item "1. Pedagogical quality" (11%) and, finally, the "6. Comfort and timing management" (7%). This latter case is pointed out, in the context of the weaknesses, from the students' feeling of overwhelming as regards the academic homework and other activities during the lockdown. It is relevant to stress that some of those latter cases might also be associated with assessments issues. This is explained by the fact that students did not specify, in some cases, if the abovementioned feeling was specifically related to assessments or other academic activities in general.

Some examples of the abovementioned items as the most frequently mentioned by students are provided below:

- **Item 1—Strengths**: "The dedication of professors to fulfill all the objectives of the curricular unit." and "The commitment and attention showed by the professors who gave us online classes."; **Item 1—Weaknesses**: "It is difficult to understand the topics taught." and "The classes did not significantly contribute to the knowledge of the topics."

- **Item 3—Strengths:** "Possibility of having different tools, such as videos and files for our study." and "The availability of complementary means of study."
- **Item 6—Strengths:** "I don't waste time on transport to college." "It is more comfortable and there is less time wasted." "The speed of access that does not imply the mobility of the student on long journeys by public transport." "The fact that I could study at home, where I felt most comfortable. It was easier to manage my time and not lose contact with my family"; **Item 6—Weaknesses:** "A lot of physical and psychological fatigue from being all day in front of the computer for study and work purposes." and "The significant number of academic homework and other activities that professors required just because we are at home."
- **Item 7—Strengths:** "Encouraging autonomy in learning." and "It requires to students have greater organizational skills."
- **Item 11—Weaknesses:** "Multiple-choice tests are not adequate, as the rationale cannot be assessed." and "More assessments when compared to face-to-face classes."
- **Item 12—Strengths:** "It allowed us to acquire new knowledge and different teaching methods, which may be advantageous or applied at certain times in the future." and "The agility and flexibility required by teachers and students."
- **Item 13—Weaknesses:** "Drastic decrease of contact with colleagues and teachers." and "Lack of interaction among colleagues."

Following, **Table 3** shows the aspects mentioned by students on the strengths regarding their online learning experience, with a breakdown by groups of analysis. Differences in absolute value higher or equal to 3 percentage points between the relative frequencies obtained for any subgroups, in relation to total, are highlighted in bold.

Based on **Table 3**, the level of missing values is higher (lower) from the students' answers who are younger (older) or non-workers (workers). The item "6. Comfort and timing management" is an aspect more noticeable for the group of students who are also workers, reaching 29%. Finally, the older or worker students were also the ones who pointed out more frequently the item "12. Adaptation to online learning" (11 and 12%, respectively).

Table 4, in turn, shows the aspects mentioned by students on the weakness regarding their online learning experience, with a breakdown by groups of analysis. The cases were highlighted in bold in a similar way, as proposed for **Table 3**.

In the context of the weakness items, older or worker students were, again, more participative than the opposite group in each case (74 and 75%, respectively). Furthermore, there was a higher level of participation by students who shared their computers or used a non-proper device (i.e., mobile phones) to attend the online classes (72%). In comparison with the opposite subgroup, students from more practical courses more significantly identified the item "13. Interaction and self-confidence" as a weakness (20%), conversely to the items

TABLE 3 | Results for the strengths from the students' perspective by groups, in number and percentage.

	In number (in percentage)										
	Gender		Age		Course		Students' status		Students' condition		Total
Item	F	M	> 25	≤ 25	P	T	NW	W	SC	NSC	
0	586	248	259	575	224	610	653	181	100	734	834
	(40%)	(37%)	**(28%)**	**(46%)**	**(41%)**	**(38%)**	**(45%)**	**(26%)**	(37%)	(39%)	**(39%)**
1	81	20	45	56	22	79	60	41	10	91	101
	(5%)	(3%)	(5%)	(4%)	(4%)	(5%)	(4%)	(6%)	(4%)	(5%)	**(5%)**
2	35	29	29	35	25	39	41	23	7	57	64
	(2%)	(4%)	(3%)	(3%)	(5%)	(2%)	(3%)	(3%)	(3%)	(3%)	(3%)
3	73	37	59	51	18	92	66	44	17	93	110
	(5%)	(5%)	(6%)	(4%)	(3%)	(6%)	(5%)	(6%)	(6%)	(5%)	**(5%)**
6	344	152	231	265	132	364	297	199	54	442	496
	(23%)	(22%)	**(25%)**	**(21%)**	(24%)	(23%)	**(20%)**	**(29%)**	(20%)	(23%)	**(23%)**
7	94	44	46	92	31	107	103	35	16	122	138
	(6%)	(6%)	(5%)	(7%)	(6%)	(7%)	(7%)	(5%)	(6%)	(6%)	**(6%)**
8	9	9	16	2	2	16	4	14	3	15	18
	(1%)	(1%)	(2%)	(0%)	(0%)	(1%)	(0%)	(2%)	(1%)	(1%)	(1%)
9	7	3	5	5	4	6	6	4	3	7	10
	(0%)	(0%)	(1%)	(0%)	(1%)	(0%)	(0%)	(1%)	(1%)	(0%)	(0%)
10	14	4	12	6	3	15	11	7	1	17	18
	(1%)	(1%)	(1%)	(0%)	(1%)	(1%)	(1%)	(1%)	(0%)	(1%)	(1%)
11	17	8	9	16	1	24	20	5	1	24	25
	(1%)	(1%)	(1%)	(1%)	(0%)	(1%)	(1%)	(1%)	(0%)	(1%)	(1%)
12	114	55	104	65	35	134	88	81	24	145	169
	(8%)	(8%)	**(11%)**	**(5%)**	(6%)	(8%)	**(6%)**	**(12%)**	(9%)	(8%)	**(8%)**
13	35	16	27	24	20	31	36	15	6	45	51
	(2%)	(2%)	(3%)	(2%)	(4%)	(2%)	(2%)	(2%)	(2%)	(2%)	(2%)
14	29	20	31	18	12	37	28	21	4	45	49
	(2%)	(3%)	(3%)	(1%)	(2%)	(2%)	(2%)	(3%)	(1%)	(2%)	(2%)
15	43	31	34	40	21	53	50	24	21	53	74
	(3%)	(5%)	(4%)	(3%)	(4%)	(3%)	(3%)	(3%)	**(8%)**	**(3%)**	(3%)
16	2	1	2	1	1	2	2	1	1	2	3
	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)	(0%)
Total	1,483	677	909	1,251	551	1,609	1,465	695	268	1,892	2,160
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	100%

"11. Assessments" (10%) and, although with a less significant difference, the item "1. Pedagogical quality" (8%). Finally, the item "13. Interaction and self-confidence" was also more expressively felt as a weakness by older or worker students (17 and 19%, respectively), which can be potentially explained by the greater willingness to accept new technologies by the younger ones.

The next section is dedicated to the discussion, limitations, and avenues for future research.

DISCUSSION

This article summarizes, from the answers provided by HEIs students to two open questions, the positive (strengths) and negative (weaknesses) aspects of their online experience, motivated by the first lockdown. For this purpose, the aspects pointed out by the 2,107 students were classified. These aspects were particularly in line with similar studies on this period of ERT (e.g., Gonçalves et al., 2020; Cacault et al., 2021; Flores et al., 2021; Ismaili, 2021; Ozfidan et al., 2021; Parker et al., 2021).

More specifically, and regarding the main strength stressed by students, comfort and timing management was the one most rated, standing out from the rest. This corroborates the literature, as being able to attend classes anywhere, namely at home or work, saving time and money on long journeys are seen as the most positive aspect of the ERT experience by students (Gonçalves et al., 2020; Ismaili, 2021; Ozfidan et al., 2021; Parker et al., 2021).

The pedagogical quality, including teacher availability, pedagogical methods, and support, was also stressed as positive, as well as the item Moodle, files, and other resources (regarding the diversity and quality of the materials provided), which is aligned with previous studies (Flores et al., 2021; Parker et al., 2021). The adaptation to online learning, including the use

TABLE 4 | Results for the weaknesses from the students' perspective by groups, in number and percentage.

	In number (in percentage)										
	Gender		Age		Course		Students' status		Students' condition		Total
Item	F	M	> 25	≤ 25	P	T	NW	W	SC	NSC	
0	524	215	240	499	193	546	566	173	79	660	739
	(34%)	(31%)	**(26**%)	**(38**%)	(33%)	(33%)	**(37%)**	**(25%)**	**(28%)**	**(34%)**	**(33%)**
1	164	85	106	143	48	201	160	89	38	211	249
	(11%)	(12%)	(11%)	(11%)	**(8%)**	**(12%)**	(10%)	(13%)	(13%)	(11%)	**(11%)**
2	8	6	11	3	4	10	7	7	2	12	14
	(1%)	(1%)	(1%)	(0%)	(1%)	(1%)	(0%)	(1%)	(1%)	(1%)	(1%)
3	22	9	22	9	2	29	15	16	6	25	31
	(1%)	(1%)	(2%)	(1%)	(0%)	(2%)	(1%)	(2%)	(2%)	(1%)	(1%)
4	59	21	42	38	21	59	52	28	19	61	80
	(4%)	(3%)	(5%)	(3%)	(4%)	(4%)	(3%)	(4%)	**(7%)**	**(3%)**	(4%)
5	33	11	29	15	15	29	22	22	11	33	44
	(2%)	(2%)	(3%)	(1%)	(3%)	(2%)	(1%)	(3%)	(4%)	(2%)	(2%)
6	111	36	52	95	44	103	121	26	15	132	147
	(7%)	(5%)	(6%)	(7%)	(8%)	(6%)	**(8%)**	**(4%)**	(5%)	(7%)	**(7%)**
7	49	36	19	66	21	64	71	14	11	74	85
	(3%)	(5%)	(2%)	(5%)	(4%)	(4%)	(5%)	(2%)	(4%)	(4%)	(4%)
10	46	17	26	37	22	41	44	19	7	56	63
	(3%)	(2%)	(3%)	(3%)	(4%)	(2%)	(3%)	(3%)	(2%)	(3%)	(3%)
11	241	99	134	206	57	283	236	104	41	299	340
	(16%)	(14%)	(14%)	(16%)	**(10%)**	**(17%)**	(15%)	(15%)	(14%)	(15%)	**(15%)**
12	29	30	36	23	17	42	29	30	6	53	59
	(2%)	(4%)	(4%)	(2%)	(3%)	(3%)	(2%)	(4%)	(2%)	(3%)	(3%)
13	213	94	155	152	114	193	174	133	34	273	307
	(14%)	(13%)	**(17%)**	**(12%)**	**(20%)**	**(12%)**	**(11%)**	**(19%)**	(12%)	(14%)	**(14%)**
14	17	13	19	11	9	21	16	14	5	25	30
	(1%)	(2%)	(2%)	(1%)	(2%)	(1%)	(1%)	(2%)	(2%)	(1%)	(1%)
15	19	12	24	7	8	23	10	21	3	28	31
	(1%)	(2%)	(3%)	(1%)	(1%)	(1%)	(1%)	(3%)	(1%)	(1%)	(1%)
16	13	14	11	16	9	18	17	10	6	21	27
	(1%)	(2%)	(1%)	(1%)	(2%)	(1%)	(1%)	(1%)	(2%)	(1%)	(1%)
Total	1,548	698	926	1,320	584	1,662	1,540	706	283	1,963	2,246
	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	(100%)	100%

of the available technologies, resilience, as well as autonomy, self-motivation, and learning process were also considered strengths to point out.

In what concerns the main weakness rated by students, there was not a single one that stands out. Instead, different aspects, such as assessments, interaction and self-confidence, and pedagogical quality, arose.

Regarding the assessments, in particular, students set out their disapproval of the online assessments and the impact on their grades, particularly with multiple-choice tests, which were seen as more difficult and unfair. These corroborate the literature in what concerns the influence of the online assessments methodology on the students' perception of ERT (Flores et al., 2021; Maraqa et al., 2021; Pettigrew and Howes, 2022). In addition, time management difficulties, with students' feeling overwhelmed with the academic homework, were another weakness of this experience, aligned with previous research

(Hensley et al., 2021; Ozfidan et al., 2021; Parker et al., 2021).

Regarding the item interaction and self-confidence, the lack of interaction, close relationships, and support (not only by teachers) were also seen as a weakness of ERT, which may be explained by the need for social interaction during the lockdown according to the literature (Elfirdoussi et al., 2020; Gonçalves et al., 2020; Lassoued et al., 2020; Muhammad and Kainat, 2020; Cacault et al., 2021; Ismaili, 2021). This is also a fundamental aspect to keep in mind when deciding about future higher education programs (e.g., face-to-face, online, or blended learning), which can be affected by some specific characteristics of either students or courses.

Although the pedagogical quality was pointed out as a positive aspect, only 5% of the students highlighted it. Conversely, 11% of them stressed this as a weakness of the ERT that stresses the importance of the teacher in the learning process and for the

students' satisfaction (Flores et al., 2021; Ozfidan et al., 2021; Parker et al., 2021). Given that students had higher expectations regarding teachers' technical and affective roles (Sason et al., 2022), they may have felt that many teachers were not prepared for the online learning challenges.

About the influence of sociodemographic characteristics in the student's perceptions, age, and students' status showed the most relative differences concerning the comfort and timing management, and adaptation to online learning items within the strengths.

In contrast, the age, type of course, and students' status had the most relevant differences in assessments and interaction and self-confidence items regarding the weaknesses.

These findings corroborate those of Todri et al. (2021), who pointed out that distance learning may be more appropriate for those who work, as well as Aristovnik et al. (2020), Gonçalves et al. (2020), and Parker et al. (2021), in what concerns the easier adaptation of theoretical courses to online learning.

Regarding gender, it was not found significant differences concerning the students' perception of ERT, which is aligned with the findings by Flores et al. (2021). However, it can be seen as a controversial aspect, as other researchers have reached different conclusions (e.g., Aristovnik et al., 2020; Bisht et al., 2020; Maraqa et al., 2021; Warfvinge et al., 2021).

Finally, as the main limitation of this article, it can be stressed the subjectivity related to the classification and analysis proposed, given the underlying constraints inherent in the clear identification of the strengths and weaknesses from the students' answers.

Further research may also explore the items and demographic variables proposed in this study through more robust analyses, such as regression, cluster analysis, and other quantitative methods.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article can be made available by the authors under request, without undue reservation.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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Engaging and Empowering Malaysian Students Through Open and Distance Learning in the Post-COVID Era

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With the outbreak of COVID-19, online open and distance learning (ODL) has become increasingly relevant, particularly among those who aim to pursue postgraduate studies. ODL provides an opportunity for many to study while working or raising a family. Nevertheless, ODL programs are associated with low student engagement and high non-completion rates compared to traditional programs. Among the main contributing factors are communication and course design, which relate to the level of responsiveness of instructors and the quality of course design thus delivery through online. An innovative approach is needed to address these issues, and heutagogy seems to be a viable alternative. Nevertheless, the heutagogical approach alone is incomplete without considering the instructional scaffolding technique that can affect adult students' engagement. This study introduces a model that combines heutagogy and instructional scaffolding (HEIS) as a guideline in conducting a fully online ODL course called Technology and Media Design. It interrogates the impact of the course design from the perspective of postgraduate students and instructors in one of Malaysia's public universities. Recommendations include for faculties with ODL courses to continuously help develop instructors' competencies and using more suitable assessment approaches e.g., project-based.

Keywords: ODL, heutagogy, instructional scaffolding, instructor competencies, project-based assessment

INTRODUCTION

Heutagogy or self-determined learning (Blaschke, 2018) is geared for professionals and part-time learners. With the advancement in technology, a heutagogical approach able to make learning more meaningful for these groups which consist of mostly people over 25 years of age (Chao et al., 2007). Open and distance learning (ODL) education is a suitable tool for the learning process, as evidenced by its acceptability by a number of higher education institutions (Dzakiria et al., 2005). Even before the COVID-19 outbreak, the Malaysian government had already given full support to ODL. The initiative to integrate the heutagogical approach in ODL is in line with the initiatives by the Ministry of Education to transform the model of Malaysia's education system. Professionals and part-time learners can now improve their skills without having to pursue formal learning in universities, allowing them to make their lives and work more meaningful. Several studies have

discussed the prospect of incorporating heutagogy into online learning (Anders, 2015; Crosslin and Wakefield, 2016; Parra, 2016; Blaschke, 2021). The literature reports despite the affordances of the online learning there are various challenges in the implementation of heutagogical approach and more research is needed to improve online learning experience through the approach (Blaschke, 2021). Therefore, it is important to first recognize the features of the heutagogical approach as outlined by Blaschke (2012), which are:

(1) students set the learning contract,
(2) a flexible curriculum,
(3) students lead the learning activities, and
(4) assessment(s) of the students are flexible and negotiable.

Despite of the flexibility offered by heutagogical approach; it is still not enough to guarantee learning success. Previous studies indicate that there are significantly higher student dropout rates in online courses than in traditional courses due to course design and a lack of communication (Musingafi et al., 2015; Khan et al., 2017; Soffer and Cohen, 2019). Their findings imply that the implementation of the heutagogical approach alone may not necessarily guarantee students will complete their studies (Lock et al., 2021). Since mature students favor discussions that encourage deeper thinking (Olaniran, 2020), this study suggests to integrate the scaffolding technique to facilitate discussion and thinking. Scaffolding has been established as an effective method for promoting engagement, empowerment, and critical thinking (Hsieh, 2017; Weinstein and Preiss, 2017; Nachowitz, 2018; Bloomberg, 2021). Hence, the instructional scaffolding technique (Pattalitan, 2016), which has been tested in other studies, serves as a reference for this study. This technique is seen suitable for mature learners who require little control from their instructor and tend to seek assistance when deemed necessary. A number of studies, e.g., in medicine (Eachempati et al., 2017) have ventured into combining heutagogical and scaffolding approaches, but there are only a few in the Malaysian educational technology context, particularly with the perspectives of both postgraduate students and instructors (Marcut and Chisiu, 2018). This gap calls for further exploration of this area, guided by a suitable model.

LITERATURE REVIEW

Studies suggest that the heutagogical approach is more suitable for mature or autonomous learners than younger learners (Canning and Callan, 2010; Blaschke, 2012). However, while mature students tend to be independent, it does not mean that they do not require an instructor's assistance at all. Canning and Callan (2010) stated that for the implementation of the heutagogical approach to be successful, students must have high motivation to achieve all of the objectives set for them. The authors added that in order to be highly motivated, motivational enhancements must be provided at the beginning of the learning process. These will help to prepare students for the learning process and more importantly, boost their confidence to voice out their opinions. A suitable strategy to achieve these aims is by recognizing that they are professionals and have extensive

knowledge that can benefit others. Students need to realize that the heutagogical approach emphasizes knowledge sharing rather than merely focusing on knowledge accumulation. Thus, heutagogy may be successfully implemented if:

- students are open-minded, willing to share their knowledge and experiences with other students,
- students are able to influence the perceptions of other students or individuals, and
- students become agents of change.

The heutagogical approach encourages students to be connected to the community. They should be allowed to build relationships as this process will help to shape their personality and create competent and capable learners (Hase and Kenyon, 2001). However, the approach is still considered as inconsistent with the current practice of many higher institutions (Moore, 2020). Pedagogical and andragogical approaches are preferred as these approaches give academicians less worries in handing over full authority to their students. Conversely, for mature learners, the existing curriculum requires restructuring to enable the evaluation of students based on their learning process (Ashton and Newman, 2006; Lee and McLoughlin, 2007; McAuliffe et al., 2009). This personalization that heutagogical suggests is able to help students feel empowered and encourage greater engagement (Blaschke, 2012).

Teaching mature students can be challenging, especially when it is composed of 100 percent online learning. Students need to be prepared and instructors need to help students to accept new learning styles with appropriate scaffolding methods (Blaschke, 2012). Hence, the instructors must be proficient in offering scaffolding to avoid impeding the development of learners' autonomy skills. Several studies have shown that Vygotsky's social-constructivism (Vygotsky, 1980; Saleem et al., 2021) provides a suitable guide for using scaffolding to teach mature students due to the emphasis on social interactions (Shah and Rashid, 2017; Lasmawan and Budiarta, 2020).

Vygotsky's concept of scaffolding is also known as zone of proximal development (ZPD) (Wood et al., 1976). The ZPD concept suggests that a more knowledgeable other (MKO) should assist others during a difficult learning period. This MKO is often an instructor, or in many instances, peers. Vygotsky believes that peer interaction is an essential part of the learning process, even though, not all more knowledgeable peers are willing to teach others. Here, the instructor plays a crucial role in creating interactive opportunities for dialogues and reflections between the MKO and peers (Wang, 2016). When students are in this ZPD, the instructor should provide them with appropriate assistance and tools to enable them to work together toward accomplishing a new task or skill. In finding the best technique for the instructor to implement scaffolding, the instructional scaffolding technique has been referred to Pattalitan (2016). This technique suggests for:

(1) continued contact in and outside the classroom,
(2) collaboration instead of competition and isolation,
(3) practical applications,
(4) prompt feedback,

(5) well-planned learning tasks for better time management,
(6) clear learning outcomes, and
(7) opportunity to showcase talents.

Based on other research recommendations, this study incorporates the components of heutagogy (Blaschke, 2012; Blaschke and Hase, 2015) and instructional scaffolding (Pattalitan, 2016) into the model that forms the basis for the study (**Figure 1**). This model is tested to understand its effectiveness and shortcomings. Heutagogy provides the main structure of the HEIS model, which is divided into three phases: first phase (learning contract), second phase (learning activities), and third phase (learning outcomes). Instructional scaffolding is incorporated into the first and second phases to intensify the interactions involving the instructor and peers. All the activities in the HEIS model are done fully online between the instructor, students, and their peers.

First Phase (Learning Contract)

Learning begins with an icebreaking session and students are asked to form groups. Each group is required to work on their learning contract. During this phase, the instructor provides a draft of the learning contract. Students are allowed to add more requirements based on their group discussion and agreement. The instructor also briefs the students on the flexible curriculum and flexible assignment submissions. Students receive clear explanations of the expected outcomes of the course and are offered support comprising:

- assistance with understanding new concepts or ideas,
- assistance with gaining a deep understanding of a topic by challenging the students,
- assistance with evaluating ideas or practices,
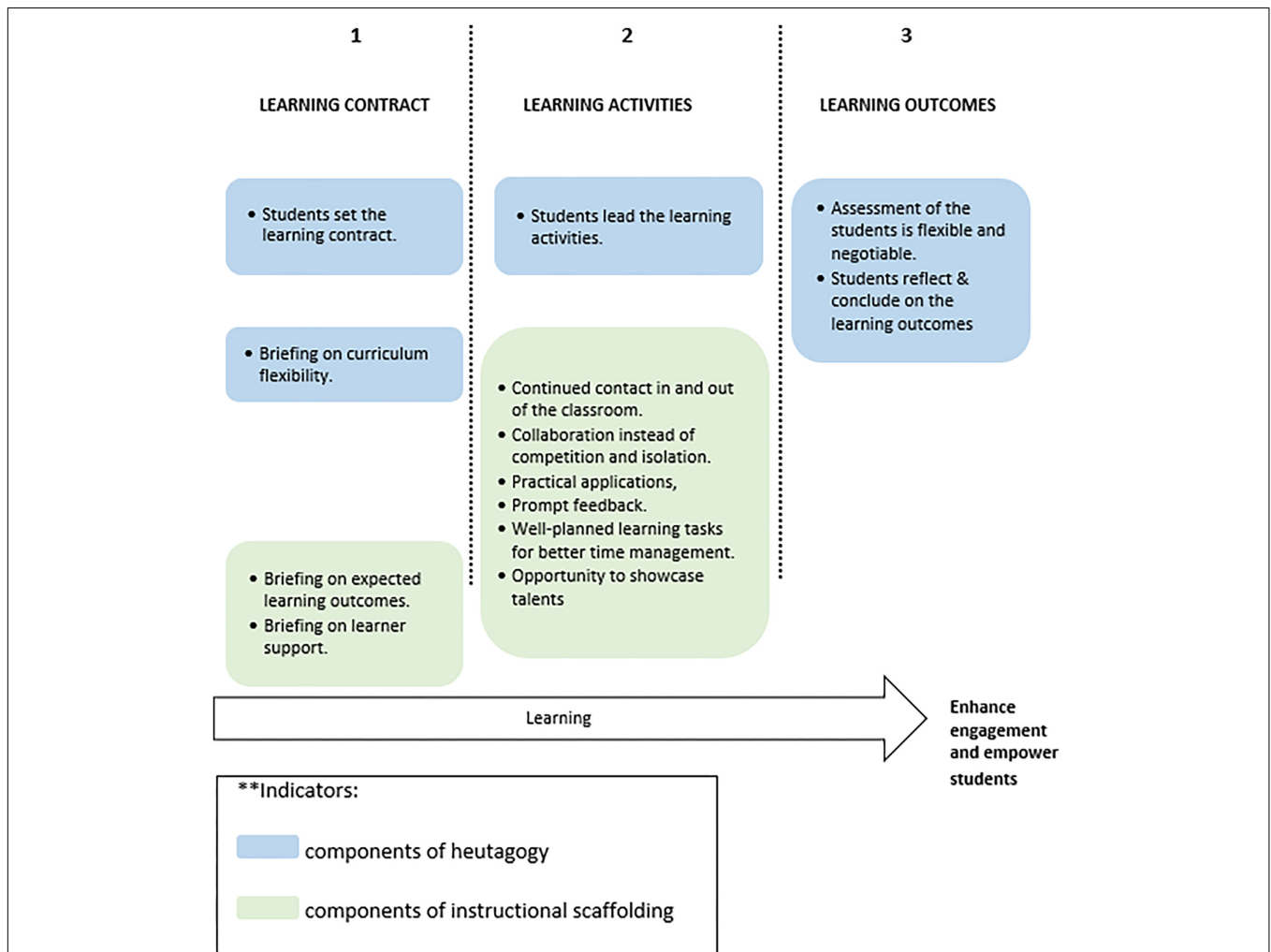- other types of assistance, e.g., wellbeing, counseling, and mental health.

Figure 1. Heutagogy and instructional scaffolding (HEIS) model

FIGURE 1 | Heutagogy and instructional scaffolding (HEIS) model.

Second Phase (Learning Activities)

At this stage, the instructor has already prepared all the course materials and made them available on the learning platform (e.g., notes, demonstration and tutorial videos, links to related websites or YouTube). In this case, the learning platform is developed based on Moodle learning management system (LMS) at https://odlsystem.utm.my/. Students are able to view the course materials anytime and in any way they like. They may negotiate on the appropriate online meeting date and time with their instructor. Scaffolding in this phase involves a MKO (Stylidis et al., 2022), which could be an instructor, a better-informed peer, or even a supporting learning material. Students need to work together in completing the assignments given. They are encouraged to provide feedback on each other's work. The assignments given also lead to applications in the real world, for example, improving the website design of an existing school. Students need to showcase their designs and be willing to receive comments and suggestions for improvement from the instructor and other students. The instructor is on a standby mode for any enquiries or guidance, including through communication via WhatsApp for continued contact.

Third Phase (Learning Outcomes)

As mentioned earlier, students are given the flexibility to submit assignments at their convenience throughout the semester. However, all the submissions must not exceed the final date before the semester ends. Final date refers to 3 weeks before the semester ends. Students are also allowed to negotiate alternative ways to complete their assignments. They must then provide justifications (in the final reflective report) for what they have achieved at the end of the learning process in the third phase. This will improve their understanding of the strengths and weaknesses of their work.

OBJECTIVES

1. To understand how the components of heutagogy and instructional scaffolding affect students' engagement in ODL.
2. To understand how the components of heutagogy and instructional scaffolding affect students' empowerment in ODL.

RESEARCH QUESTIONS

1. How do the components of heutagogy and instructional scaffolding affect students' engagement through ODL?
2. How do the components of heutagogy and instructional scaffolding affect students' empowerment through ODL?

RESEARCH METHODOLOGY

This study used a qualitative approach involving semi-structured interviews whilst the main objective of the study is to understand

FIGURE 2 | Research design.
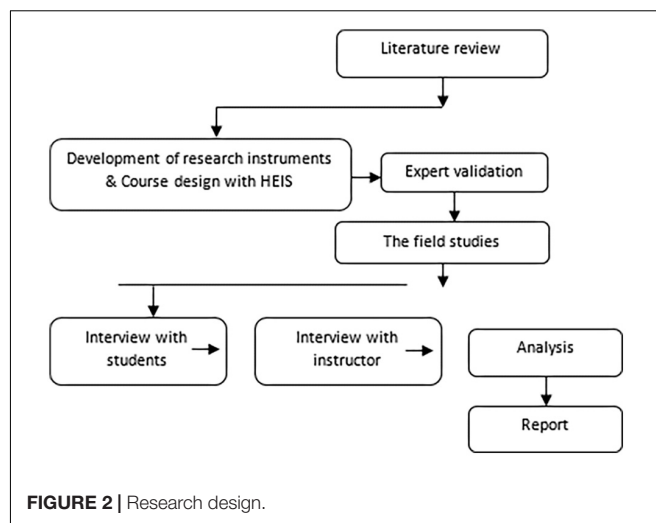
the experiences of the research participants (Denscombe, 2010). Purposive sampling was used in selecting the participants (Punch, 2013).

Figure 2 illustrates the research design of this study which involves structuring the interviews into two parts. The first part involved distributing the semi-structured interview questions online (using the Google form) to twenty postgraduate students aged 25–50 who enrolled in the ODL course of Technology and Media Design in one of Malaysia public universities. The second part consisted of one-on-one interviews to gain a more in-depth understanding and to allow other relevant themes to develop throughout the interviews (Bradford and Cullen, 2012). The interview questions were validated by an educational technology expert who was not involved in this study (Taherdoost, 2018). Four students gave their consents for the one-on-one interviews. The interviews were all conducted online due to the COVID-19 outbreak and because the students were all located in remote locations across Malaysia. An interview with the instructor was also conducted for triangulation with the data collected from the students (Flick, 2018). The confidentiality of the students and instructor is maintained by changing their names in this study (Allen, 2017).

This study applied two methods of analysis, namely thematic (Braun and Clarke, 2006) and comprehensive data treatment (Silverman, 2020) which includes the views from both sides of the participants (students and instructor). The thematic approach allows for careful analysis in finding coherent and distinctive themes by first, determining the codes. In determining the codes, another colleague who did not participate in the study took part as the second coder and verifier. The entire data were then coded using the NviVo 12 software. Based on the codes collated, two key themes were identified.

DISCUSSION OF RESEARCH FINDINGS

The discussion is based on the two research questions to understand the effect of heutagogy and scaffolding (HEIS) on enhancing engagement and empower students' learning.

(1) How do the components of heutagogy and scaffolding (HEIS) affect students' engagement through ODL?

The first question is answered using the findings related to the instructor's competencies, as discussed below:

KEY THEME 1: INSTRUCTOR'S COMPETENCIES

Studies have indicated that instructors' or teachers' competencies have a strong impact on students' emotions and effective learning (Gläser-Zikuda and Fuß, 2008; Darling-Hammond et al., 2017; Helin, 2021). Instructor's competencies in this study highlights the need for instructors to have certain skills in engaging mature students to learn online fully. Conceptual, interpersonal, and technical skills were found to be most valued by the mature students in this study. Instructor's competencies are also closely related to the study of scaffolding (zone of proximal development/ZPD) which suggests that support should be given to students at the early stages of learning (Tinungki, 2019). Support can be in many forms depending on the situation. In the context of this study, the supports required by the students were related to learning preparation, effective communication, and technological tools.

To generate the key theme (instructor's competencies) and three sub-themes (conceptual, interpersonal, and technology skills), initial codes were generated first whereby chunks of data from the semi-structured interviews with the 20 participants were examined line by line (Bryman, 2004). As a result, seven codes were generated, as shown in **Table 1**. Some of the codes overlap; these were developed further into categories.

These codes are not closed categories, as sometimes they could overlap. The codes were grouped into potential categories, which are conceptual, interpersonal, and technology skills as shown in **Table 2**. The data were constantly reviewed using the NviVo 12 software to ensure the two categories fitted the data codes.

Sub-Theme 1: Conceptual Skills

Based on the data analysis, instructor's conceptual skills were found to be one of the important factors of student engagement. Conceptual skills refer to the abilities to understand situations, organize, and implement solutions to ensure goals are achieved (Katz, 2009). Therefore, instructors need to be able to manage the ODL courses well by first, explaining the importance of the learning contract clearly to students. Learning contracts were found to be extremely effective in keeping the students engaged (Mohamed Ibrahim and Ali Eldemerdash, 2018) as they already have a preliminary agreement that will take effect if they fail to fulfill the terms of the agreement.

In being assertive, there needs to be flexibility when dealing with mature learners. Nonetheless, it does not mean they can break the rules (learning contract). Instructors need to observe the situation and allows some flexibility to the students. For example, even though students are not required to submit assignments by specified dates throughout the semester, they should not submit their assignments later than 3 weeks before semester ends.

Instructors also need to be observant of students working in groups and be willing to offer their expertise when needed. Instructors should not assume that no issues will arise when mature students are working together in groups. As one of the students mentioned:

TABLE 1 | Codes and indications from semi-structured interviews.

Code	Indication	Definition	Sample of participants' quote
CCI	Clear and concise instructions	Providing clear and concise instructions and expectations for students.	"We wouldn't want our marks to be affected if we break the learning contract. The instructor has made this clear from the beginning" [Student D]
CFX	Curriculum flexibility	The curriculum is designed to meet students' needs and capabilities.	"I would say that I am more advanced as compared to my other friends because I'm currently working in the design industry…well. I did submit one of the assignments earlier than everyone else. I felt relieve after submitting. I can get on with my work and not worry about the assignment anymore. I'm very busy, you see [laugh]" [Student A]
KN	Knowledgeable	Someone who is well-versed in a particular subject or field.	"Sometimes it is difficult for us to agree on a decision so we will refer to the instructor to get a more comprehensive view before continuing the discussion" [Student H]
AC	Accommodating	Willing to extend help without hesitation.	"I'm glad that I can simply message or call my instructor for help at any time. There was once when I message her at almost midnight, and she replied! That really helps as I was under stress to understand and complete the assignment given" [Student G]
SE	Sensitive	Quick to detect or respond to the surrounding, signals, or feelings of others.	"It was great that we can agreed to meet online at certain time, especially at night. I've to rush from work after 5:00 p.m., to get home, get my kids settled…so it is a bit chaotic for me and for some of my friends in the course…there was few times that I can't attend the meeting but luckily the instructor managed to record the meeting for those who can't attend. We managed to refer back to what was discussed" [Student C]
TS	Tech-savvy	Able to use a variety of smart device, software, and tools for teaching.	"Learning is not boring because the instructor used a variety of approaches. Sometimes she uses Padlet, Webex, Zoom, free video recorded apps. All kinds of software…there were some software that are new to me. This is useful not only for learning but for my work as well" [Student H]
SPT	Solve problems with technology	Know how to overcome technical issues with technology	"My internet line is sometimes unstable but I'm not worried because the instructor will record everything, and I can watch it later. Plus, the instructor uses WhatsApp and Facebook for backup" [Student K]

TABLE 2 | Categorizing codes from semi-structured interviews into three sub-themes.

Codes (see Table 1)	Categorization of codes into sub-theme
CCI, CFX, KN	Conceptual skills
AC, SE	Interpersonal skills
TS, SPT	Technology skills

"Sometimes it is difficult for us to agree on a decision so we will refer to the instructor to get a more comprehensive view before continuing the discussion."

[Student H, semi-structured interview]

Mature learners have high expectations in pursuing knowledge and skills that are worth their time or money (Jones et al., 2018). Therefore, it is imperative to create and manage a course that will maximize their strengths, meet their individual needs, and address all the learning challenges.

Sub-Theme 2: Interpersonal Skills

Interpersonal skills refer to the skills to communicate and interact with other people (Hayes, 2002). Instructors need to have interpersonal skills to teach effectively because those skills can influence emotions, and emotions are proven to help shape student engagement and learning (Linnenbrink-Garcia and Pekrun, 2011). Students in this study stated that the accommodating and sensitive attitude of the instructor has influenced their engagement in learning. Other studies have also reported that educators who are accommodating (supportive, kind, and nurturing) have a positive impact on learning (Feshbach and Feshbach, 2009; Pit-ten Cate et al., 2018).

Mature students face certain challenges when learning from home. In addition to their responsibilities as students, they must deal with family members including young children at the same time. Moreover, the students who enrolled in the ODL course in this study held high positions at work (e.g., director, manager, and assistant principal). Therefore, it is not surprising that they had high expectations. The students in this study requested for less synchronous meetings and recommended for the meetings to be conducted in the evenings to give space to them, especially for those who are parents. Besides, the students expected the instructor to be reachable when needed. Similarly, other research findings suggested that instructors should provide quick responses for effective online learning (Baker, 2011; Boettcher and Conrad, 2016). Problems will arise if the instructor refuses to accommodate such requests because mature students will not hesitate to quit their studies, as explained by one of the students:

"I once decided to quit but the instructor approached me, and she gave some suggestions for completing the assignment. She also gave additional one-on-one learning session. She made me stay."

[Student G, one-on-one interview]

The data show that interpersonal skills through positive communications are vital for ODL instructors to develop and possess in order to establish a trusting relationship

(Duffy et al., 2004). The data also show that empathy is the key to interpersonal skills quality (Lloyd and Maas, 1992). Empathy is the ability to put oneself in other people's shoes and understand a situation from their point of view. Several studies have emphasized the importance of empathy in online learning (Fuller, 2012; Osler, 2021), and this study fully supports those findings.

Sub-Theme 3: Technology Skills

Technology skills refer to the ability to integrate technology into teaching and learning (George et al., 1996). The instructor in this study emphasized that technology skills can help smoothen the learning process, as exemplified by the following incident:

"...yes, instructors need to have skills in using not just one software but various! We cannot rely on just one software...anything can happen online, so we need to always have backup. There was once I used "zoom" and I had some problems with it, I quickly switch to "Facebook live"...learning continued and I didn't have to cancel the class."

[Instructor, one-on-one interview]

Without technology skills, as mentioned by the instructor, students' learning experience may be adversely affected and become unpleasant. The instructor's skills in video recording were also mentioned by the students by referring to the video lectures that were made available for them to revisit if needed.

"...the instructor managed to record her lectures and we were able to watch at any time. Just like books, I watched her lectures again before the final exam [laugh]."

[Student C, one-on-one interview]

All the data indicate that instructors need to be prepared and open to any possibilities when teaching mature students through ODL. Instructors need to have skills in planning and handling their ODL classes with the aid of technology.

(1) How do the components of heutagogy and scaffolding affect students' empowerment through ODL?

To answer the second research question on students' empowerment, six codes were generated (**Table 3**), which were then categorized into three sub-themes (**Table 4**) leading to the formulation of key theme 2 (project-based assessment).

KEY THEME 2: PROJECT-BASED ASSESSMENT

Project-based assessments seem to play an important role in empowering students. All the three sub-themes identified in this study lead to the key characteristics of project-based assessment (Beckett and Slater, 2019). Therefore, this study suggests that project-based assessments should be incorporated in ODL and analyzed in future studies. Moreover, other studies have indicated that project-based assessments will encourage empowerment by improving self-confidence and promoting collaborative and

TABLE 3 | Codes and indications from semi-structured interviews.

Code	Indication	Definition	Sample of participants' quote
CT	Communication tool	Utilize communication tool for discussion and deep learning	"We used WhatsApp group for brief discussion followed by Zoom for deeper discussion. These tools allow us to communicate on the move. We can reach all members located in different state and country. Besides, it's cost-effective" [Student E]
CL	Collaborate	Working with another to produce or create something	"We were not competing with other groups, instead we were asked to provide feedback to improve the design produced by other groups and vice versa. This is healthy" [Student S]
SRP	Solving real problems	Solving situations that cause difficulties for people.	"I like the third assignment given where we have to solve real problems. This helps us make connections and gain deeper understanding" [Student L]
AVE	Assessment vs. Evaluation	Process oriented assessment instead of product or outcome oriented.	"Actually, I don't like having a final exam for this kind of course. We learn about design, something that is subjective and require constant improvement. So why is there a need for a final exam? We are not school students [Laugh]" [Student A]
RAB	Reduce assignment burden	Burden reduction from many assignments.	"Can I suggest reducing the number of assignments? when combined with all the assignments from other courses we feel burdened" [Student H]
FA	Focused assessment	Assessment focusing on a particular problem identified in real world.	"…Instead of three, why not just give us one meaningful assignment to be completed throughout the semester for a course like this?" [Student J]

TABLE 4 | Categorizing codes from semi-structured interviews into three sub-themes.

Codes (see Table 1)	Categorization of codes into sub-theme
CC, CL	Collaborate and communicate
SRP, AVE	Real task
AVE, RAB, FA	Meaningful Assessment

problem-solving skills among students (Meyer, 2014; Amissah, 2019; Warnock and Duncan, 2019).

Sub-Theme 1: Collaborate and Communicate

Despite the physical absence, students were able to collaborate through the online platform to complete their assignments. Learning in collaboration has been shown to have numerous benefits, such as developing higher-level thinking skills, improving confidence, and empowering students (Laal et al., 2012, 2013). Collaboration enables students to learn from each other as they discuss solving problems and making decisions. However, the students mentioned that they favor discussions in small groups due to the greater sense of commitment (Bondie, 2020).

"I don't think this will work in bigger group! Three in a group should be enough. It's easier to manage and we gained quality discussion. Plus, everyone gets to participate."

[Student C, one-on-one interview]

Students have used various technologies, such as WhatsApp and Zoom as a medium for communication. Nonetheless, WhatsApp was not considered the best communication tool for more in-depth discussions.

"We used WhatsApp group for brief discussion followed by Zoom for deeper discussion. These tools allow us to communicate on the move. We can reach all members located in different state and country. Besides, it's cost-effective."

[Student E, semi-structured interview]

This contrasts with one study (Urien et al., 2019) that stated WhatsApp is a key factor that helps undergraduate students

working in groups solving complex tasks. With conflicting findings between undergraduate and postgraduate students, further studies can be done to see if age factor is the cause of differences in using communication applications such as WhatsApp for the learning process.

Sub-Theme 2: Real Task

Students in this study stated that they prefer to deal with assignments that are authentic or related to the real world because such assignments allow them to gain a better understanding of issues (Pieratt, 2019).

"I like the third assignment given where we have to solve real problems. This helps us make connections and gain deeper understanding."

[Student L, semi-structured interview]

Solomon (2003) in his study of project-based learning also stated that students feel more empowered when dealing with authentic tasks as they take learning more seriously.

Sub-Theme 3: Meaningful Assessment

It is important to highlight that the most distinguishing feature of an ODL course compared to a face-to-face course is the assessment part. According to the instructor in this study, there is a need to properly analyze the appropriate types of assessment for ODL courses. She specifically mentioned that the mastery learning approach is not as suitable for teaching ODL among adult students from diverse backgrounds:

"We need to be more creative in using different approaches than the mastery learning. That approach does not encourage empowerment. We have students from diverse background and some of them are more advanced than the others…of course they wish not to learn the basic topics anymore."

[Instructor, one-on-one interview]

Students also conveyed their disagreement with using final examinations to assess their learning achievements for the course.

"Actually, I don't like having a final exam for this kind of course. We learn about design, something that is subjective and require constant improvement. So why is there a need for a final exam? We are not school students [Laugh]."

[Student A, semi-structured interview]

Online final examinations cannot prevent cheating, and according to the instructor, many similarities were found in the final examination answers submitted by some students.

"Final exam is no longer suitable for this course. Despite being given 2 days of open book exam, I found that there were students who plagiarize with more than 60% similarity."

[Instructor, one-on-one interview]

Many studies have raised the issue of online assessment or e-assessment leading to plagiarism and fraud (Gathuri et al., 2014; Mellar et al., 2018). A study also showed that students of ODL-based learning had low trust in e-assessment and suggested that further studies to be conducted to identify the causes (Kocdar et al., 2018). Thus, this study provides some answers by asserting that e-assessment should first be tailored to course specific content e.g., for design courses, project-based assessment approach is considered appropriate.

CONCLUSION

This study has applied the HEIS model that combines heutagogy and scaffolding. Even though all the HEIS components have an impact on students' engagement and empowerment, there are still some suggestions for improvement. This study recommends that instructors' competencies and project-based assessments be considered in ensuring the effectiveness of the model.

The HEIS model has unearthed the importance of instructors' competencies in ODL. To implement all the criteria proposed by HEIS effectively, instructors must first develop competencies (conceptual, interpersonal, and technology) to scaffold mature learners in ODL courses. Therefore, the faculties with ODL courses should not assume that their existing instructors can teach these courses. Even with many years of teaching experience, instructors should still be given proper training on teaching mature students in a fully online environment. The findings also indicate that project-based assessment is more suitable for ODL design courses. Project-based assessments are indeed worth

considering to deal with the issues of academic dishonesty and plagiarism when more learning institutions are moving online due to the COVID-19 pandemic situation.

Is it also important to highlight that this study involved a small sample of university postgraduate students and academic in one of Malaysia public universities therefore the findings cannot be statistical generalized. However, this can be related to naturalistic generalization that focus on the discovery of general principles about phenomena rather than sample of representation (Yin, 2009). The findings can provide important information for future research on implementing heutagogical approach for online teaching and learning in Higher Education. It is hoped that faculties, researchers, and other practitioners will be able to use this study's findings and recommendations as a useful reference.

DATA AVAILABILITY STATEMENT

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

AUTHOR CONTRIBUTIONS

ZA and MNH contributed to conception and design of the study. MNH organized the database/system and proofread the article and article submission. ZA performed the qualitative analysis and wrote the first draft of the manuscript. Both authors contributed to manuscript revision, read, and approved the submitted version.

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Design-Based Learning as a Pedagogical Approach in an Online Learning Environment for Science Undergraduate Students

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Design-based learning (DBL) is a learning strategy that requires students to use their theoretical knowledge to develop an artifact or system to tackle a real-life problem. DBL has long been utilized in design-related curricula in higher education such as engineering, computer science, and architecture. However, little is known about how DBL in non-design-based courses enhances students' learning experience, especially in recent years when the COVID-19 pandemic has compelled the worldwide education systems to adapt to online learning. Hence, this study aims to investigate the experience of science undergraduate students after one semester of participating in online DBL. The participants include 25 second-year science undergraduate students enrolling in the Managing New Technologies course. Using semi-structured interviews and thematic analysis, the findings of this study indicated that online DBL contributes to easy access to learning, enhances creativity, and allows students to think outside the box. Nevertheless, students highlighted online learning as an obstacle to their DBL experience. They claimed that online platforms as a means of communication are not practical due to insufficient interaction time and misunderstanding of information. In addition, some students stated that the online environment poses difficulties for collaborative learning.

Keywords: pedagogy, design based research, online learning, non-design based courses, higher education

INTRODUCTION

Design-based learning (DBL), also known as design-based science (Fortus et al., 2005; Vattam and Kolodner, 2006), design science research (Peffers et al., 2007), or learning by making (Shanta and Wells, 2022), is a learning method where students evaluate their understanding through design. Using their knowledge, students provide a solution by participating in designing activities (Felix, 2016) — a learning strategy that is frequently linked with design and technology education (Zhang et al., 2020) — to solve real-world problems through the construction of innovative and creative products.

According to Joordens et al. (2012), DBL enhances students' imagination, creativity, and talents while improving higher order thinking and understanding. Studies have shown that students improve their systems thinking, transdisciplinary activities, and collaborative skills through DBL (Wells, 2016; Baron and Daniel-Allegro, 2019; Huang et al., 2019), which further allows them

to apply concepts in various contexts. However, the nature of teaching and learning has altered due to rapid advancements in information and communications technology. The introduction of a new teaching and learning environment known as online learning has been facilitated by the digital transformation of education systems at all levels. It is a web-based system that uses digital technology with a range of web-based educational resources to provide students with an open, interactive learning environment that helps them learn more effectively (Rodrigues et al., 2019). At present, online learning is a form of education where students pursue learning activities digitally rather than in a traditional classroom setting.

While lecturers and students will benefit from online learning through the use of digital technology that provides insightful lessons, self-directed learning development, and interactive environments, online learning may still be a problem for those who do not have access to proper digital tools. This is further worsened by the coronavirus (COVID-19) pandemic, which has caused higher education systems worldwide to adopt online learning and impacted the students' mental health, study-life balance, and academic engagement.

Research by Irawan et al. (2020) shows online learning during the COVID-19 pandemic greatly effect students' mental health. They found that after 2 weeks of participating in online learning, students reported experiencing emotional instability, a lack of enthusiasm, and anxiety disorder. AlJhani et al. (2021) found similar results. Their study on medical students across Saudi Arabia found that 94.4 percent of respondents reported moderate-to-high stress levels due to the changes from normal classrooms to online classes during the COVID-19 pandemic.

Based on a study conducted on 367 Malaysian tertiary education students by Moy and Ng (2021), the sudden transition from face-to-face lectures to online classes, coupled with students' insufficient knowledge of information technology, hinders students' ability to adapt to the online environment, leading to a reduction in academic engagement. Meanwhile, Aguilera-Hermida (2020) and Farrell and Brunton (2020) reported that the most difficult problem students had during online learning due to COVID-19 was balancing between studying and daily life activities. There were numerous distractions, including family and household chores.

Since DBL in traditional classrooms has improved student skills and fostered collaboration (Wells, 2016; Baron and Daniel-Allegro, 2019; Huang et al., 2019), it is crucial to investigate the DBL experience of students in an online learning environment. Furthermore, as previous research has predominantly focused on engineering education or design-related courses, such as computer science and architecture, where the students are often trained in digital tools and software, it would enrich the field to explore DBL in the context of non-design-based courses.

AN OVERVIEW OF DESIGN-BASED LEARNING AS PEDAGOGY

Design-based learning is based on the constructionist theory, which states that learners construct knowledge rather than passively taking in information. While it highlights the importance of producing or engaging in designing activities as a means of learning, the design process also offers a valuable learning environment. Therefore, DBL values both the learning process and its outputs or products. DBL was created in the 1980s, and it was initially used in high schools to educate science and develop design skills (Doppelt et al., 2008). Designers (learners) build products or artifacts that symbolize a relevant learning output, and this is an active learning process that puts students at the center, encouraging them to participate actively in class. Briefly, in DBL, students are taught to develop prototype models or artifacts of a problem-solving solution. It is a teaching technique that helps students generate creative products and improves their willingness to study (Ahmad Alif and Syahrul Nizam, 2019).

This pedagogical approach combines problem-based learning with project-based learning in which students apply theoretical information obtained in the classroom to design products, systems, and inventive solutions (Gómez Puente et al., 2013; Zhang et al., 2020). DBL has been utilized in design-related courses in higher education such as engineering, computer science, and architecture; nonetheless, courses other than design such as science, accountancy, and social sciences have recently begun to incorporate DBL into their curriculum (Ford et al., 2017; Tang and Sun, 2017; Fried et al., 2020; Zhao et al., 2021).

The literature has discussed good learning outcomes from DBL as a student-centered approach. Besides fostering collaboration, DBL also allows students to learn at their own pace, encourages transdisciplinary learning and cooperation, stimulates creativity, and increases student confidence (Raber, 2015; Chen and Chiu, 2016; Zhang et al., 2021). Since the complexity of a task usually involves collaboration and specific responsibilities, students can become "experts" in a specific area by establishing goals and constraints using representational approaches, idea development, and prototype construction for design projects. As a result, students can work in groups, share information, and develop their abilities (Doppelt et al., 2008). DBL also helps improve students' cognitive and social abilities, for instance, public speaking and critical thinking skills during an oral presentation by defending and justifying their products and how they fit the standards. Ultimately, this helps enhance their interpersonal communication and problem-solving skills (Doppelt, 2006; Zhang et al., 2021).

ONLINE LEARNING

The digital transformation of education systems worldwide has facilitated the introduction of a new teaching and learning environment known as online learning or electronic learning (e-learning), which allows students to share information regardless of their locations. Owing to its flexibility in delivering and accessing learning content, online learning also enables students to study whenever and wherever they want.

Various studies have highlighted the benefits of online learning. For instance, online learning enables self-paced learning that fosters lifelong learning (Njenga and Fourie, 2010;

Al-Fraihat et al., 2017), while the internet and multimedia technologies in the classroom have increased delivery and learning accessibility (Elfaki et al., 2019). Roddy et al. (2017) also outlined four pillars to ensure student success in online classes: (i) academic supports through easy access to online academic resources and student-instructor interaction opportunities; (ii) technical assistance that helps students prepare for online learning; (iii) support for health and wellbeing, (iv) a sense of belonging to a community in terms of how students interact with their peers, lecturers, and the environment.

Nevertheless, according to Roddy et al. (2017), technical difficulties, confusion with the learning content, balancing between study and family responsibilities, perceived isolation, and a lack of motivation are among the difficulties of online learning that should be considered. This includes communication and engagement between teachers and students, which is a barrier in the online learning environment (Alawamleh et al., 2020). In addition, Dumford and Miller (2018) also asserted that online learning hinders students' collaborative learning experiences by resulting in lower-quality interactions.

DESIGN-BASED RESEARCH FRAMEWORK

Design-based research methodology entails a research design that combines design and scientific methods to create new theories, artifacts, and practices (Easterday et al., 2014). According to Amiel and Reeves (2008), the design-based research approach involves four phases:

1. An analysis of real-world issues.
2. Solution development based on existing design concepts and technological advancements.
3. Evaluating and refining solutions in iterative cycles.
4. Reflection to develop design ideas and improve solution implementation.

These phases are systematic yet flexible, and the principles are adjustable and feasible for others interested in studying similar settings. However, despite a variety of design-based research processes highlighted in the literature, there is no one-size-fits-all design-based research process as the planning and implementation of research projects differ depending on the situation (Rossi, 2021) and can, therefore, change depending on the design goals and circumstances. Nonetheless, many of these design-based research frameworks have been discussed in the context of related technical activities such as engineering, information science, and computer science where the students are mostly equipped with digital tools and software training (e.g., Peffers et al., 2007; Wyk and Villiers, 2014; Geitz and de Geus, 2019).

A combination of design learning frameworks proposed by Peffers et al. (2007), Wyk and Villiers (2014), and Geitz and de Geus (2019) were adapted according to the suitability of this study. This new design-based research process involves five phases: (i) identify problems in the context of current situations and generate ideas; (ii) define a solution's objectives;

(iii) design and development; (iv) demonstration and reflection; (v) communication and evaluation. Specifically, the design-based research process focuses on identifying issues in situations at present and producing innovative ideas to encourage students to design a solution based on their critical-thinking abilities. As the study was conducted in an online learning setting where face-to-face interactions are limited, it is essential to integrate communication and evaluation to allow students to interact with their lecturer and peers as well as examine whether or not the objectives and outcomes of the assignment have been met.

Based on the above discussion, the five phases of the synthesized generic design-based research model were applied in the learning process of university undergraduate students. Additionally, the following research questions were used as guides to explore the experience of students participating in online DBL:

RQ1: How does online DBL benefit students?
RQ2: What are the challenges faced by students in online DBL?

LEARNING ENVIRONMENT

This qualitative study was employed to investigate the benefits and challenges faced by students during online DBL. According to McGrath et al. (2019), qualitative research interviews are appropriate for gathering informative insights into people's experiences and allow in-depth analysis from a small sample size. The participants for this study were 25 second-year science undergraduate students enrolling in the Managing New Technologies course. Managing New Technologies course is the elective program course to provide students with knowledge on the nature of new technologies and the importance of technology management. Throughout the semester, the lecturer explains various concepts and theories related to technology management in the class. This helps students to understand the scenario. Due to the recent COVID-19 pandemic, all teaching and learning activities in the university have shifted to online learning; therefore, the course was entirely delivered online *via* google meets apps.

As a component of their assessment, students were given a group task to design a prototype for solving a real-world problem, focusing on the process of design and the techniques used to come up with innovative ideas. Students were given autonomy to choose their group members. A typical group consists of five members in a group. In the group, they identified the problem they wanted to solve. At the end of the semester, students need to orally present innovative solutions to explain the product, types of innovation they used to develop solutions, and SWOT (strengths, weaknesses, opportunities, and threats) analysis. In other words, the presentation's content should relate the design with the students' theoretical knowledge. **Table 1** describes the framework of the design-based research process applied during the DBL.

Interviews were done a week after the project presentation. Each interview session lasted approximately half an hour to an

hour. Students were informed before the interview that their participation was entirely voluntary and that the interview would not be used to evaluate them. Before the interviews, an informed consent form was given to the students. The interviews were done in groups depending on the project groups of the students. A group interview is an interview method that involves a group of people at the same time, whether in a formal or informal (Fontana and Frey, 2000). Typically, group interviews were performed to reminisce about events that the respondents had in common. This type of data collection is flexible, low in cost, and provides rich data. However, as Fontana and Frey (2000) point out, findings from group interviews cannot be generalized since individuals may dominate the group, resulting in "groupthink."

Some of the open-ended questions that were asked are: (1) What do you like about DBL?; (2) How does DBL contribute to your learning development?, and (3) Please share your experience regarding the online DBL experience. Thematic analysis was used in the data analysis process. To develop similar themes, the coding was done manually following Braun and Clarke's (2006) six-step framework (i.e., familiarizing yourself with the data, creating codes, searching for themes, reviewing themes, defining themes, and writing up). During the coding process, research questions were used as a guide. The coding process began with the generation of initial codes after becoming familiar with the transcripts. Both researchers went through each transcript, coding every section of the transcript that related to the research questions. Both researchers compared the codes and the coded section and discussed how to achieve the agreed codes for the data. Following this, the researchers again coded the coded sections with the agreed codes only. Finally, both researchers grouped the codes into possible themes. Based on Braun and Clarke (2006), the themes were then reviewed to ensure that the coded data was relevant and supported the themes. Five themes were identified from the transcripts: i.e., online learning setting, enhanced creativity, collaborative learning, human interaction, and thinking outside the box. The following section explores these themes.

RESULTS

Online Learning Setting

The students deemed their online DBL experience enjoyable because it allows for easy access to learning and project materials.

"Accessibility is another advantage of online design-based learning, both in terms of time and space."

"...we can google information and watch videos that help broaden our ideas to increase our creativity."

Nevertheless, the students highlighted the inconsistent internet line as an obstacle to their studies.

"An online class is a bit stressful because some students have internet connection problems, so we cannot focus during our lecture due to the surrounding noises that can disturb our concentration."

"Online learning only left us sitting for hours in front of the screen, expecting us to focus and complete all our assignments, which can be ridiculous sometimes."

TABLE 1 | Application of the design-based research process.

Phase	Activities
Identify problems in the context of current situations and generate ideas	• At the beginning of the semester, the lecturer introduced the course, and throughout the semester, the lecturer explained various concepts and theories connected to technology management. This facilitates the students' understanding of the scenario. • Students worked in groups to identify the problem they intended to solve. Students were given the option of selecting their preferred group members. • To create innovative designs, students performed background studies to explore alternative solutions.
Define a solution's objectives	• Students need to specify the solution or the design to be produced. • Students present their idea/proposal and modify their idea based on the feedback from peers and the lecturer.
Design and development	• Students begin designing their prototypes. • The lecturer monitors their progress through online tutorial classes. • Students in groups need to write and verbally report on their progress. • Student design must be completed by the final week.
Demonstration and reflection	• During the final week, students in groups present their designs online and explain how the theories learned in class were applied to the design.
Communication and evaluation	• Question and answer sessions were also held to allow lecturers and peers to understand the design produced. • Students submitted their finished work to an online platform for grading by the lecturer.

Enhanced Creativity

Based on the data, online DBL enhances students' creativity by allowing them to use their imaginations in the project and helping the students broaden their ideas about innovation.

"It (online DBL) makes us more creative, and we find that, nowadays, it is important to have designing skills. Besides that, design-based learning helps broaden our idea about innovation."

"It (online DBL) is unlike any other assignments that we have done so far as it boosts our creativity skills and offers a different approach to learning technologies."

"We get to apply the theory we learned more creatively."

"We also like that we were given a chance to design our very own product according to our likings."

Collaborative Learning

According to the students, the advantage of online DBL is that they no longer need to travel anywhere for a discussion. The students also said they could share tasks and learn from their team members because every team member has different necessary skills to design the prototype.

"We can communicate and collaborate with our group members and brainstorm among ourselves."

"So, by having a team, they (team members) can share the task and complete it together."

"(Online DBL) Allowing students to tackle more complex problems than they could on their own — to delegate responsibilities."

Nonetheless, although working in a group has its advantages, some students mentioned the difficulties in collaborating online. According to the students, they quickly became bored during online group discussions due to being in front of the screen for an extended period. Some team members might also be left behind due to connectivity problems, which causes discomfort to the group. Moreover, online group discussions can also increase the possibility of being distracted by other online sites.

"Internet connection differs from one student to another, which means that during group work (discussions), a team member may get left behind while others are busy discussing the matter."

"(It is) Difficult for students to discuss desired products and design with their group members online or *via* a video call because not all of them have a good internet connection."

"We also find it hard to focus in class since there are a lot of distractions such as an unstable internet connection. In fact, we do not have face-to-face classes — this makes it easier for us to lose focus because there is not too much engagement."

Human Interaction

The students claimed that online platforms as a means of communication are not practical due to insufficient interaction time and misunderstanding of information. Besides, according to the students, it is challenging to stay focused during learning without the actual presence of their lecturers and classmates. The students also reported that they lack motivation and feel isolated due to this limitation.

"With traditional learning, communications between students and lecturers as well as among students will be easier. Students can easily ask lecturers any questions and have effective communication."

". . .it is hard for us to focus in class since there are a lot of distractions such as an unstable internet connection. In fact, since we do not have a face-to-face class, it is easier for us to lose focus because there is not too much engagement."

". . .it is harder (for us) to concentrate in class during online learning due to the lack of human interaction, body language, and physical learning atmosphere."

Think Outside the Box

According to the students, DBL allows them to view objects beyond their physical appearances. In fact, such a pedagogy helps students go beyond their typical learning and stimulate their thinking.

"(Online DBL) Helps us to think outside the box and be more observant of our daily life."

"(Online DBL) Indirectly explains that every problem has a solution where we are required to identify a problem and a solution for it."

"We will not see a product as just one product, but we will see a product as an achievement in fulfilling all the aspects involved."

"It (online DBL) makes us creative, and we find that it is important to have designing skills nowadays. Besides that, design-based learning helps us broaden our ideas about innovation. . .."

"(Online DBL is) Interesting and fun because we get to challenge our creativity and certain skills such as critical thinking skills."

DISCUSSION

Overall, most of the students had a positive experience in online DBL and acknowledged its benefits. Based on the findings, the students deemed their online DBL experience enjoyable and exciting because the pedagogy takes a distinct learning approach. Design-based activities also permit them to develop products based on their interests, thus allowing them to employ their imaginations in the creation process while broadening their understanding of innovation and managing new technology. Ultimately, DBL develops students' metacognitive skills and enables them to see objects beyond their physical appearances. This finding was aligned with a study by Joordens et al. (2012), who stated that DBL improves students' creativity and imagination.

Meanwhile, working in a team implies both advantages and disadvantages in this situation. Even though teamwork encourages responsibilities and learning with complementary skills possessed by each individual in the team, collaborative learning is not easy for some of the team members because some of them might be left behind, for instance, due to connectivity issues. Besides, collaborative learning tasks are not only focused on getting the job done but also on the experiences and decision-making of the team members; hence, their commitment from the beginning of the project is necessary.

Nonetheless, the students highlighted the challenge of remaining engaged in learning without the physical presence of their lecturers and classmates. Even though online learning offers borderless online activities, it tends to hinder lecturer-student interactions, thus making the students feel isolated and demotivated. This is agreed to in the study by Alawamleh et al. (2020) that showed online learning has a negative effect on lecturer-student interactions.

Evidently, DBL is a type of pedagogical learning that allows students to apply prior knowledge and problem-solving abilities. Simultaneously, it enhances students' talent and creativity through gathering information from various resources and developing solutions through a design. While the findings of this study suggest that students recognize the advantages of DBL, most of the challenges related to DBL could still be attributed to online learning. Indeed, the online environment hinders their collaborative learning and self-motivation.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Chairperson, Malaya Research Ethics Committee (Non-medical). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

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Developing a Solution for Hybrid Classroom: A Pilot Study From a Malaysian Private University

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The COVID-19 pandemic brought about an opportunity for higher education institutions (HEI) to explore modes of education delivery other than face-to-face (F2F) and remote learning *via* fully online mode. The HEIs faced challenges for "business to resume as usual" when not all students were able to return to campus due to being held back in their home state or countries due to different stages of lockdown at their locations. At Taylor's, a hybrid learning mode was thought of to be the solution that can cater both to students who are on-campus and those who are off-campus. A pilot project based on a very practical-oriented classroom from the School of Food Studies and Gastronomy (SFSG) and Taylor's Culinary Institute (TCI) was kick-started to ensure a seamless learning experience for the students. The "pandemic pedagogy" based on real-life needs can be an opportunity to scale up learning for borderless learning in the future. This study reports on the initial development process and challenges and the findings from the pilot studies using a design-based research (DBR) approach.

Keywords: hybrid learning, borderless learning, pandemic pedagogy, design-based research, e-Learning

INTRODUCTION

The COVID19 pandemic brought about the uncertainties for business operations to run as usual, and this includes the higher learning institutions (HEI) worldwide. Given the highly infectious nature of the COVID-19 virus, classes had to be switched from corporal to virtual spaces almost instantaneously to ensure lessons can continue. Conducting classes in virtual spaces in a fully online mode has become the new norm since 2020 for most HEIs. "Pandemic pedagogy" that started as a Facebook group to support education providers navigate through the uncertainty and trauma of the pandemic became a new term introduced to describe this new norm in education delivery (Schwartzman, 2020).

As the situation around the pandemic gradually improves with new vaccines discovered, the HEIs will need to come up with a contingency plan to wade through the uncertainties around different countries' standard operating procedures (SOP) around managing the pandemic. The borders will slowly reopen and international students, as well as local students from different states will re-enter the universities in phases to continue their education. This study discusses the very early stages of the implementation of a hybrid learning solution at Taylor's University and Taylor's

College (Taylor's) to address the flexibility for any time and anywhere learning by ensuring learners can learn both on-site and remotely for a meaningful learning experience because of the COVID-19 pandemic where some students are not able to attend classes on campus. As the implementation will happen in several phases of development, a design-based research approach was implemented as its research design to investigate the learner's learning experience in a hybrid mode by examining the learning platform's ease of use, functionality, and user interface. The learner's feedback will be used by the practitioners who are the course instructors and learning technologists to improve the pedagogy and the design of the learning platform and technologies to best support the hybrid learning mode in a hands-on classroom like the kitchen.

BACKGROUND

The idea of conducting learning entirely online was conceived at Taylor's in 2018 under the new Taylor's Curriculum Framework (TCF), 2 years before the COVID-19 epidemic aggressively struck the world in 2020 (Lessler, 2018). The TCF Policy and the e-Learning Strategic Plan guide the campus-wide curriculum aimed at transforming learning into an online mode under this TCF. The original goal of the e-Learning Strategic Plan was not only to complement face-to-face (F2F) learning with online learning but also as a contingency plan for a time when the university would be partially or completely shut down so that classes could continue. The COVID-19 epidemic cleared the path for a new approach to the pedagogy implemented at Taylor's as hybrid learning to ensure learners both in-campus and off-campus can harmoniously learn together. However, how could the practitioners trace that the online technologies implemented to aid learning and teaching for a practical course in the kitchen are effective to replace face-to-face (F2F) learning and teaching pedagogy? How can the inconvenience of the spartial gaps in a very hands-on class be addressed when it is fully online? Hence, the pilot Digital Exemplar Kitchen (DEK) addresses the challenges in designing a learning space to cater to learners in F2F and virtual spaces. This innovation enables the course instructor to interact seamlessly with their learners in two separate modes of learning.

Hybrid Learning

The term hybrid learning is often used interchangeably by educators to describe blended learning or dual-mode learning, and quite frequently, the term is not clearly defined and often caused confusion (Heriot-Watt Learning Teaching Academy, 2022). Linder (2017) described hybrid learning as the deliberate use of technology to substitute class time to establish a learning environment. Saichaie (2020) on the other hand defined hybrid learning closer to blended learning or flip learning, where the approach is replacing one class period with technology-enhanced activities in a learning platform either to be completed as self-paced or collaboratively with peers. The hybrid learning in implementation from previous literature informed releasing learners from the confinement of a physical space into the virtual space to allow flexibility in class scheduling.

HyFlex, short for Hybrid Flexible Learning, on the other hand, is a term used by Beatty (2019) for a learning approach that gives flexibility to the students to select the choice of learning that best suits their needs, e.g., either F2F or online mode, based on the four key principles i.e., learning choice, equivalency (between the participation modes), reusability, and accessibility. HyFlex was originally conceived to accommodate the graduate students' working schedule, so they are given the flexibility in their learning mode. Boyarsky (2021) and Gaebel et al. (2021) provide a definition closer to what learning in Taylor's is implemented in ensuring synchronous learning can continue for learners who are in-campus and off-campus, where the off-campus students appear in class using video conferencing tool (Boyarsky, 2021). In this approach, learning can be scaled up and more learners can join the course *via* the online video conferencing mode.

Borderless Learning Initiatives at Taylor's

Taylor's academic leadership shifted the direction for classes to be conducted entirely online during the lockdown, and the challenge transpired during a period of transition to normalcy while a sizable number of students were still unable to return to campus to resume classes as usual. While teaching as a hybrid mode is thought of as an alternative means to instruction during unprecedented events, there was an intentional effort prior to the COVID-19 pandemic for borderless learning for the purpose of scaling up learning at Taylor's. Conducting courses as a massive open online course (MOOC) and micro-credential were the modes experimented for borderless learning at Taylor's (Ayub and Leong, 2017; Lim et al., 2018). Nevertheless, the COVID-19 pandemic expedited the necessary processes and support from the relevant stakeholders such as the Academic Leadership Team and ICT to ensure the urgency of having a hybrid learning ecosystem at Taylor's.

The Concept of Borderless Learning

To deal with the situation, Taylor's introduced their unique "Borderless Learning" approach starting from August 2020 intake (Teaching learning for a borderless world., 2020). This borderless learning is a concurrent in-person and online class approach that aims to ensure that no student gets left behind. Through this approach, Taylor's new students will enroll in their program fully online but with the freedom to continue classes at the Taylor's Lakeside Campus at any point of time. Students with practical classes will also take turns to go back to campus for the laboratory or studio session.

There are three important components of the borderless learning approach: (i) classroom population, (ii) learning delivery platform, and (iii) communication channel. Classroom population consists of lecturers, in-campus students, and online students (see **Figure 1**). In a typical learning scenario, a course instructor is teaching in a classroom with live streaming facilities such as Zoom, ReWIND, or Microsoft Teams, and the course instructor's role will slightly change. A course instructor is now a learning curator who curates the learning activities based on the existing classroom population as well as playing the role of an online learning facilitator to facilitate those who are accessing the class online. In addition, learning circles are also

FIGURE 1 | The concept for hybrid learning in Taylor's as borderless learning.

created among in-campus and online students to ensure equal access to facts, opinions, and arguments taking place during the class.

The learning delivery platform refers to virtual learning environment (VLE) which hosts learning resources and conduct online learning activities (refer **Figure 2**). Through this learning delivery platform, students will attend live stream classes and engage with course instructors through their tutorial and interactive activities. Online tools for group activities are created so that online students can also participate and responded to the activities using icons (thumbs up in Zoom) or emojis (in Teams). In general, it is through this learning delivery platform that the lecturer will curate lessons so that it will offer a hybrid best of in-person, online synchronous, and asynchronous learning experience to students.

The third component of this borderless learning approach is the communication channel. Social media such as Telegram, Facebook group, WhatsApp, and WeChat are used as communication channels. A communication channel is a platform for students to channel all questions and comments for real-time response. To ensure effective communication and equal information dissemination, in-campus students are also encouraged to post their questions in the communication channel so that it will benefit the online students as well.

In short, borderless learning @ Taylors makes learning equitable and accessible to all students, no matter where they are or the nature of their courses. Students' learning will be orchestrated by the course instructor, who will act as a learning curator and a learning facilitator. The in-person student will be in the classroom accessing the same material as the virtual student simultaneously. This is to ensure that both the learning communities have an equal access to facts, opinions, and arguments. Upon the successful implementation of this
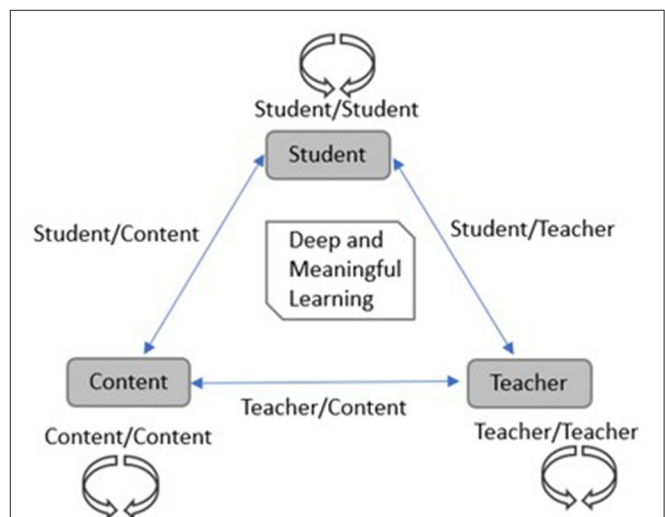
FIGURE 2 | Sample of learning activities conducted *via* borderless learning approach @Taylors.

approach, it surely can be shared and replicated by other institutions to ensure learning continuity during this pandemic.

Conducive Learning Environment During the Pandemic

In a F2F setting, although some form of pedagogical planning goes into course delivery, the interactions during the class session are spontaneous between the course instructor, the learner, and other learners. On the other hand, designing for online learning requires deliberate planning on its learning design to

ensure a certain learning object is selected to set the stage for engaging and meaningful learning. Learning in the online learning environment should be designed to mirror learning in the F2F setting. Moore (1989) and Anderson and Garrison (1998) research revealed that the most critical interaction is between teachers and students. This observation is still relevant for today's learners learning in a virtual environment. In the online environment, Moore (1989) informed three forms of online interactions: (1) learner–instructor interaction, (2) learner–content interaction, and (3) learner–learner interaction. Hence for hybrid learning, the challenge is for the course instructors to ensure they engage not just with the F2F students but also include the learners in the virtual space in the discussions or class activities.

While Anderson and Garrison have clearly outlined the online delivery strategy that it is still applicable today, pre-pandemic learning was always thought of as either F2F in the classroom or some revisions, practices, or self-learning components that will be flipped in the institution's LMS as blended learning. Hybrid learning practice pre-COVID-19 was in some way a blended learning approach with parts of the lesson in either F2F or online. It was never imagined that there was a need for a very practical course in a kitchen to be delivered entirely online. It was no longer a learner's choice to be onboard to the fully online experience, but learning online has become necessary to ensure class continuity. While research on pedagogy delivery for practical based classes to cope with the forced disruption emerged for nursing (Sharma et al., 2021; Sezer et al., 2022), psychology counselling and guidance (Alkiş Küçükaydin, 2021), undergraduate medical students and their instructors (Khanom et al., 2020; Rafi et al., 2020; Dulohery et al., 2021), teacher education (Kalloo et al., 2020), general chemistry (Wilson, 2020), the strategy of applying synchronous lecture seems to be the pedagogy method of choice while studies acknowledging the loss of "hands-on" experience and impact on the workload of the educator, the students and the educator's own educational philosophies. The studies insinuate a forced strategy to deliver lesson as synchronous online lecture was used to cope with the inability to produce high-quality instructional videos over a short time as creating self-instruction videos were noted as too time-consuming (Hodges et al., 2020; Wilson, 2020). The studies insinuate a forced strategy to deliver lesson as a synchronous online lecture that was used to cope with the inability to produce high-quality instructional videos over a short time as creating self-instruction videos were noted as too time-consuming (Hodges et al., 2020; Wilson, 2020).

On the other hand, Alkiş Küçükaydin (2021) reported that the students of the "psyhchology counseling and guidance" programme experience difficulties to develop strategies to deal with the uncertainties of learning during the pandemic period. Further, the nursing students experienced an overload of online sessions and described not learning enough to be a good nurse (Sharma et al., 2021; Sezer et al., 2022). The instructors reported decreased effectiveness of remote teaching and called for a change in the strategies for online education (Sharma et al., 2021). Some of the strategies implemented were breaking students into smaller groups for discussion and maintaining engagement with

students *via* a discussion forum, while learning online was the strategy applied for lab classes at an Arabian Gulf University (Wilson, 2020). Nevertheless, no comprehensive studies focused on practical classes conducted in a hybrid setting, with online and on-campus students attending the class simultaneously for practical classes in the kitchen, especially for student chefs who need to practice what they learn.

The Pedagogical Strategy for Hybrid Learning

In a hybrid learning setting, the course instructor must be able to skillfully manage learners in the F2F settings as well as learners in the virtual learning space as both learners will "attend" the class together synchronously. Learner engagement with the course instructor, the learning content, and their peers ensures a deep and meaningful learning experience can take place, and this is through learners' active participation in the class environment (**Figure 3**).

In a hybrid learning model, irrespective of the learning environment of the learner, they are expected to complete the same type of tasks, activities, assignments, and projects. Saichaie (2020) informed of hybrid learning models that require students to complete preliminary tasks that are the foundation in nature, prior to the synchronous class for example reviewing learning resources that can be in form of instructional videos or research articles or completing the assigned tasks in the VLE. During a synchronous meeting with students or the "class time," opportunities are given to students to discuss the content learned in the asynchronous session, or active engagement in collaborative activities with their peers to promote higher-order thinking during class time.

Asynchronous learning necessitates students building their knowledge from the ground up, and the instructor designs the course with learning resources and activities that help to scaffold the learning by focusing on lower-order cognitive processes that allow for the recall of theories, concepts, and facts. Matthew et al. (2016) shared that in-class activities should focus on achieving the learning outcomes by fostering critical thinking skills with problem-solving activities which require a student to analyze and evaluate the application of the knowledge collaboratively as a team. To ensure that a meaningful learning happens, a learning design model or a framework could be used to guide the instructors in the learning design planning (Ayub et al., 2020). The pedagogy strategy for hybrid learning must be thought of from a learner's perspective coming from dual learning modes with many of the learning design strategies adapted from the blended learning approach.

Instructor–Learner–Learners Interaction

It has been established that teaching F2F combined with online learning is the best option for teaching today's learners, and academicians should adopt a blended approach to their pedagogy for hybrid learning (Ananga and Biney, 2021). More importantly, communication between learners and instructors is crucial in creating a conducive online learning environment (Anderson, 2003). Hence, a platform that can ensure a fluid interaction for deep conversations between the online learners and instructor,

as well as online learners and in-campus learners, must be considered in the learning design of a classroom for hybrid learning. With the aid of technology that can enable hybrid learning, the course instructor must be able to seamlessly shift their attention from the F2F learners to the online learners and ensure the in-class learners and online learners can participate in discussions for collaborative activities.

Learner–Content Interaction

In the online learning environment's design, overloading learners with too much information must be avoided at all costs. Learning content shall be revealed to learners timely for effective teaching and learning. Project-based learning (PBL) allows an online classroom to be divided into teams, collaborate with their peers, share their work, and be in touch with real-world experiential learning (Lin and Tsai, 2016). Project-based learning (PBL) has been outlined as an effective way to get learners to develop engagement and interaction with the content and their peers meaningfully and is still relevant for the hybrid learning approach.

Learner–Learners Interaction (Peer Learning)

Peer learning is growing internationally as a beneficial pedagogical strategy in conceptualizing learning and teaching in the global classroom (Brannagan et al., 2013). Many researchers see learning effectively with peers as one of the wealthiest learning resources, especially when it is integrated successfully into a higher education culture (Topping, 2005; Havnes, 2008). In addition, according to the research report from the Australian Learning and Teaching Council Ltd, integration of peer learning has also been proven as an effective learning strategy, which enables students to gain confidence in their knowledge (Keppell et al., 2011). Specifically, in the blended learning environment, interaction among learners is crucial to ensure successful learning. Learning becomes more effective when participants become closer and form a stronger relationship in the learning community. This can happen during online dialogues where learning materials are discussed and members help each other to learn and understand more (Silvers et al., 2007).

The Temporary Hybrid Learning Setup and Challenges

The suggested pedagogical innovation extends the existing practice established as a temporary remedy to ensure class continuation in the present learning settings such as classrooms, lecture halls, kitchen suites, and laboratories. The location of the design case is the kitchen suites located in the ground floor area of the building. Due to the pandemic, the students could not have practical experience with their chef instructors in the kitchen suites.

The instructor chefs brainstormed ideas to incorporate interactive demonstrations at a distance using the equipment suggested by eLA (refer to **Figure 4**). Effective known methods to manage an online classroom includes (1) social presence, (2) facilitating discussion, (3) supporting students, and (4) live online teaching (Ni She et al., 2019). With disruptive technologies like

FIGURE 3 | Interaction for online learning is an iterative process between the teacher–student–content (Anderson, 2003).

FIGURE 4 | The design-case site: proposed exemplar kitchen in the culinary suite and pastry kitchen.

Zoom, chef instructors conduct virtual cooking demonstrations and facilitate discussions with the students. However, there were still limitations with having limited devices to stream the cooking demonstrations from the campus. While the gadgets suggested can quickly enable hybrid learning, in practice, due to the nature of the classroom that requires views from multiple angles of the kitchen area and different movements of the chef instructor to showcase cooking techniques, the off-the-shelf gadgets can be clumsy to be operated. As an example, a phone stabilizer or gimble (see **Figure 5**) will need a human operator with a steady hand to follow the chef instructors in the kitchen. Requiring another human resource may not be a viable option during a pandemic.

THE RESEARCH APPROACH

The transformation of the design-case sites from its traditional F2F culinary suite and pastry kitchen setting to digital exemplar kitchen (DEK) equipped with Hybrid Learning facilities must

FIGURE 5 | Some of the off the shelf Borderless Learning equipment that enables a quick set-up for Hybrid Learning.
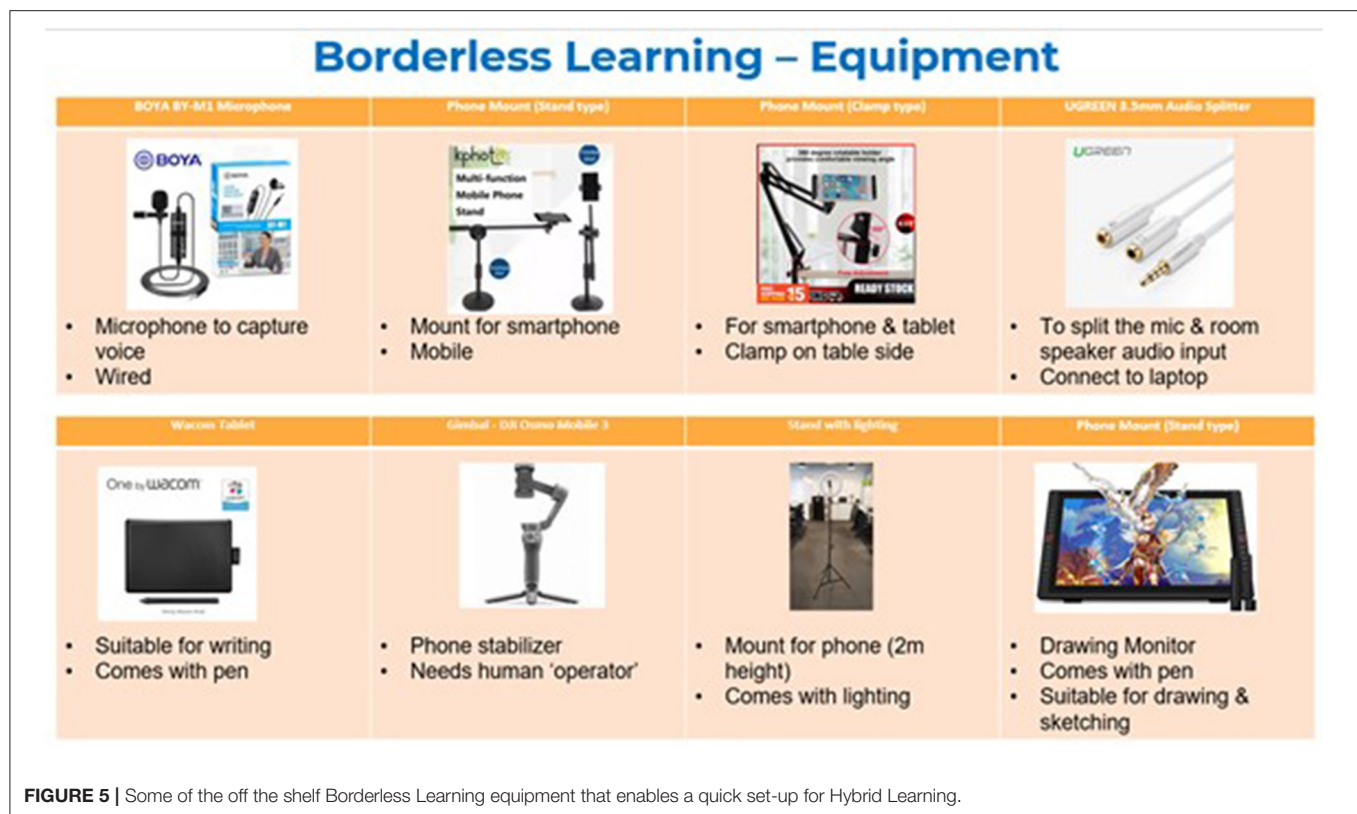
be done seamlessly. Because the DEK needed to be constructed rapidly yet using a rigorous research approach, referring to **Figure 6**, an agile Successive Approximation Model 2 (SAM2) that served as the framework for project management was adapted using design-based research approach (Penuel et al., 2011; McKenney and Reeves, 2019). The DEK will serve as a prototype for future classrooms for hybrid learning, and having a prototype is necessary to ensure the product built meets the end-user requirement and will be subject to test and refinement in iterations (Allen and Sites, 2012). Having a systematic approach to constructing a hybrid learning facility using the agile framework SAM2 will ensure that continuous improvement can be made to the process without affecting the project timeline and deliverables. The design of the DEK will be reflected upon and refined in a maximum of three iterations. Using SAM2 model, the process flow is divided into three phases: (1) preparation which includes project planning i.e., information gathering of the background information as well as brainstorming, termed as SAVVY Start; (2) iterative learning design, to create initial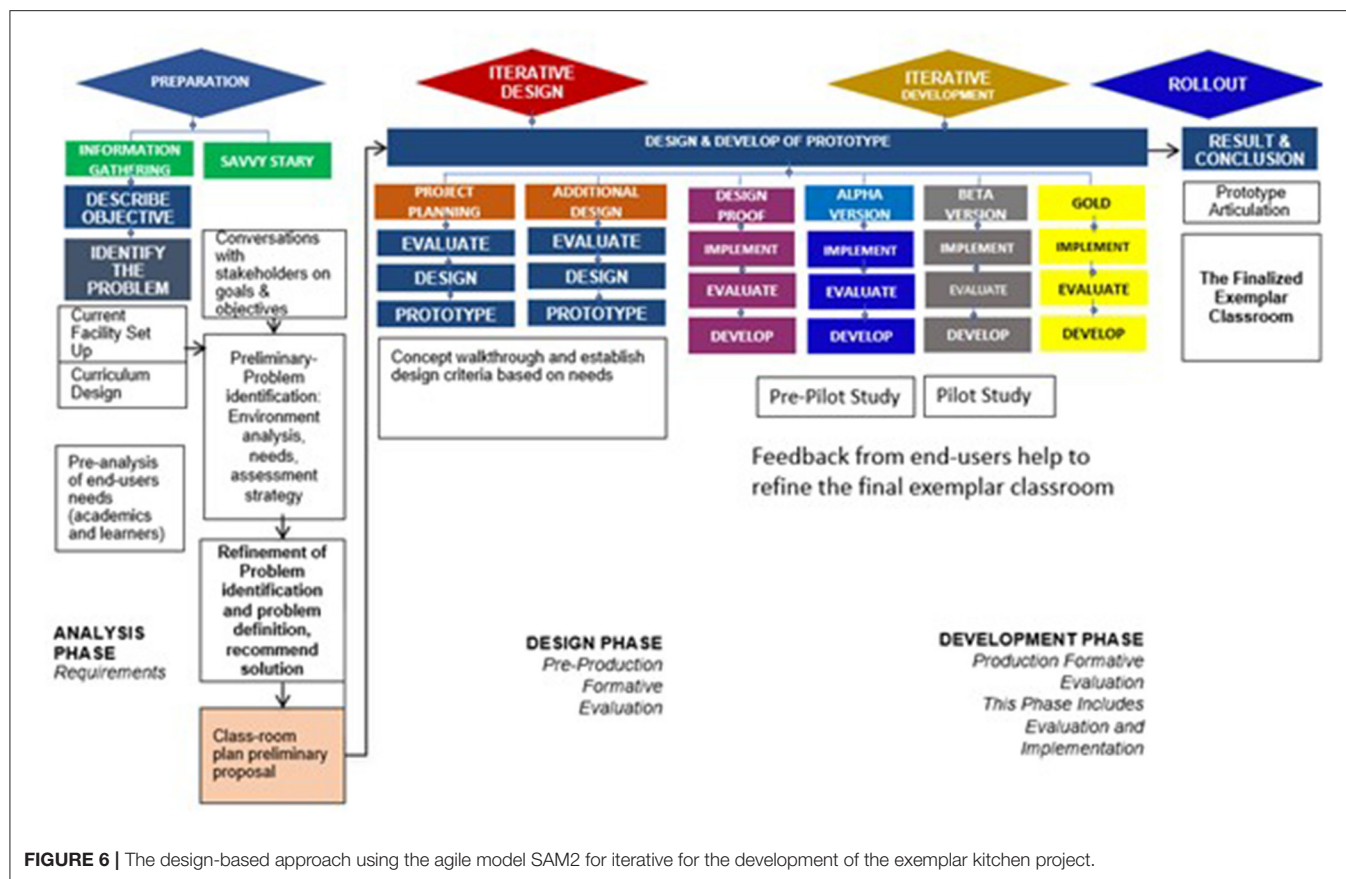 design prototype ideas and a review of the design; and (3) iterative development of the resources and activities for the hybrid learning facilities, implementing the prototype and evaluating the prototype. In each iteration, the lesson learned in the design and development of the hybrid learning facility is recorded and change is implemented in the next prototype cycle. For phases two and three, the development process is broken down into smaller incremental steps or stages, which allows the stakeholders to decide on the refinement or change required for the design

of the DEK and refine the prototype development. In the final rollout (4), the DEK shall be finalized based on reflecting on the design process and enhance the solution implementation, with inputs from experts and the key stakeholder from the school in delivering the hybrid learning solution.

Development of the First Iteration of the DEK Prototype

Due to a tight timeline given to the technologists from eLA to have the DEK sites ready to be operationalized by January 2021, the preparation phase of the design took a month followed by 2 months of iterative design and development to ensure the DEK is fully transformed into a functional hybrid classroom that meets the needs of the end-users. In finding the gaps in this design-case, the technologists reflected on the learning design process together with the stakeholder, including the end-users, that includes strategies that resonate with learning theories and best practices for a meaningful learning experience.

The DEK must be able to support both in-campus and off-campus learners and have a potential for the off-campus learners to be scaled up. However, the operations of this hybrid learning set-up were never tested before. To assist the technologists and the stakeholders to refine the design of the DEK, this first iteration, a pilot study, was conducted to include end-user's experience in the final design refinement consideration. In a design-based study, an initial study such as a pilot or focus group may be undertaken at the earlier stages of intervention

FIGURE 6 | The design-based approach using the agile model SAM2 for iterative for the development of the exemplar kitchen project.

as an opportunity for discovery to assess and revise the design prototype or "to seek proof of an impact with the intention to explain how and why the effect is observed (or not)" (McKenney and Reeves, 2019, p. 176).

In its design, the DEK focuses on delivering high-quality multimedia with interactive engaging moments with the chef instructors. The classes are streamed live from the kitchen using an online meeting platform. The camera view will be changed according to the movement of the chef instructor, which ranges from the working table to the cooking range and the oven area. With the DEK, students attend a live session with a 2-way communication whilst the session is also recorded to resolve the time zone difference for international students.

The DEK is a culmination of high-speed internet connection, online platforms, as well as disruptive educational tools. Other than Zoom, Panopto, and the hardware installed, the same learning management system (LMS), TIMeS (Moodle), was utilized as the personal learning environment (PLE). A video management system (VMS) using Panopto was integrated to make the video storing efficient for the end-users. The recordings uploaded into Panopto allow for a greater engagement with students to interact with their chefs about the instructional videos.

The hardware comprises of 42' TV for display; 8' full HD Mini Monitor panel facing the curator to allow the chefs to observe what he is doing and what the student is viewing; two (2) fixed

HD cameras pointing at a precise angle for maximum view with one (1) omnidirectional HD PTZ (Pan-Tilt-Zoom) camera that allows the curator to adjust, zoom in or out where necessary and allows the chefs to have 10 different preset camera views and a Jabra headset with noise cancellation to ensure pristine audio delivered to the audience, making the chef easy to be heard with high-definition sound quality to both ends (see **Figure 7**).

Focus of Classroom Management in DEK

For online classroom management, the chef instructors engage with students with a wide array of pedagogical methods. For example, miniature tasks were given to test students formatively based on the menu of the day to keep them concentrated throughout the session. Upon completion, the session is immediately uploaded to a video management system (VMS), i.e., Panopto that allows students to re-access ubiquitously. The proposed innovation of classroom management for hybrid learning extends to current practice and prior literature in three ways. First, prior research on the HyFlex model focused only on two learning modalities where students may choose to attend F2F class in-person or complete learning activities online without physically attending a class (Beatty, 2014; Liu and Rodriguez, 2019; Sowell et al., 2019). This model is expanded upon by adding an additional modality, i.e., the option for students to participate in a F2F class synchronously online. This option is critical in driving engagement for students who may feel distracted in a

FIGURE 7 | The technology that can implement hybrid learning at the DEK.
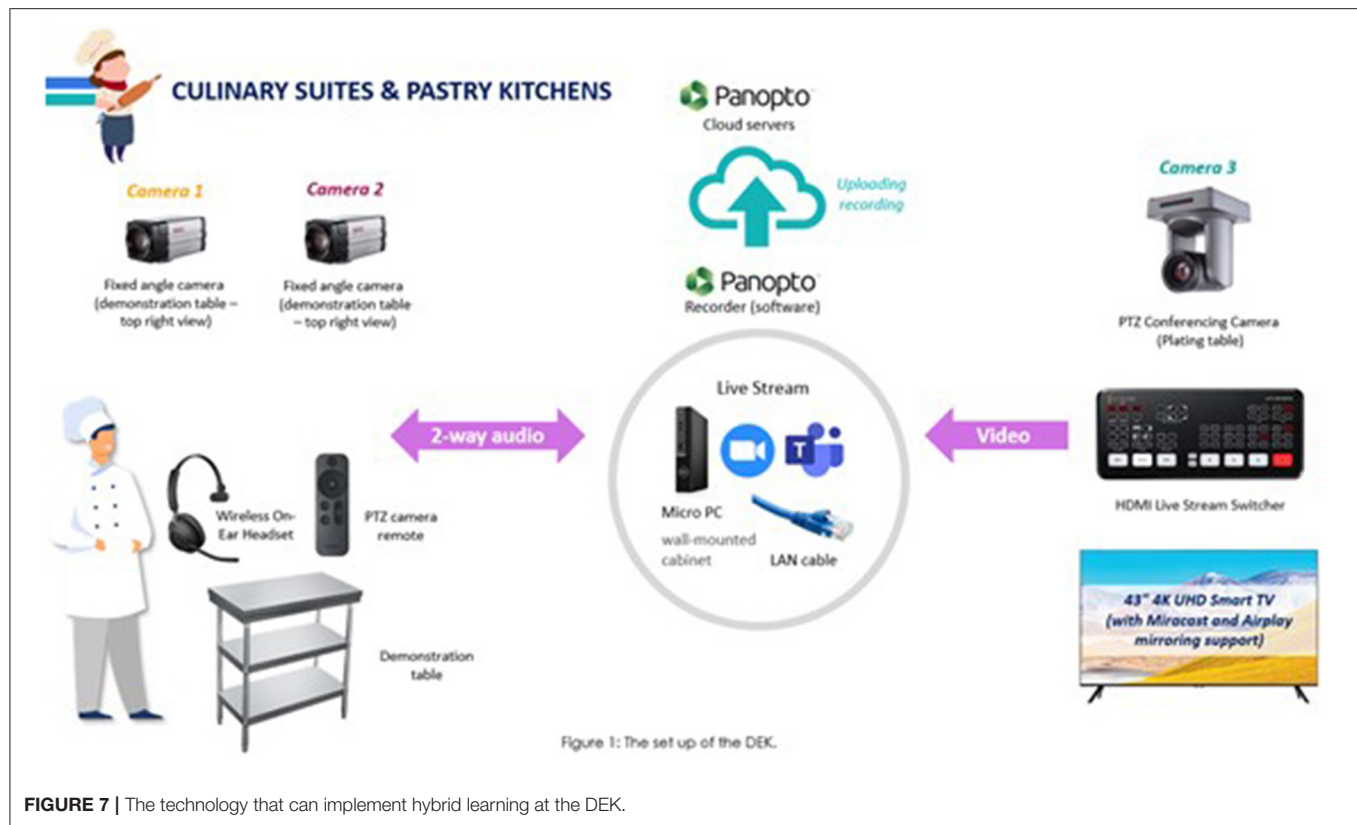
large class setting or who may feel the need to quarantine, without sacrificing the benefits of F2F interactivity. Second, the HyFlex model is further extended to not only include flexibility but also engagement. Referring to Beatty (2014) definition, HyFlex considers flexibility in terms of attendance and content delivery. However, there was no guidance on how instructors can promote student engagement in hybrid settings. The problem in practice is particularly serious for large class sizes where the instructors are already struggling with devoting attention to individual students in need or engaging them in a meaningful discussion (Dean et al., 2016). This problem is especially exacerbated in a hybrid setting, where the instructor needs to engage students in an unbiased way *via* multiple learning modalities. Third, a reference to past scholarly literature on best practices of hybrid learning environment, using existing tools and technologies, in which the chef instructors carefully craft the learning design of the course by combining a menu of different tools and options in which students can receive equitable access to content.

THE FINDINGS

The pre-pilot test was performed at a small scale, and 21 students agreed to participate in the survey to evaluate how learning was conducted as a hybrid mode in the DEK with Zoom and eventually Panopto, as the tools to present the output for the classes which was conducted in DEK. The students experienced a few sessions of learning in DEK and subsequently

answered a survey with a 5-point Likert scale. All participants' information was kept anonymous. Histogram illustrates the mean score and standard deviation regarding the item (a). Ease of use, (b) Functionality, (c) User Interface and open-ended responses were also included in each construct to further probe on how learning is experienced by learners after implementing the Hybrid Learning design set up in the DEK. In the pre-pilot test, referring to **Table 1**, the highest mean score (M = 4.24) is the 'Functionality' while 'User Interface' has the lowest score (M = 4.00). The average standard deviation (SD) on the other hand is 0.7756. The data spread from the histogram further shows a low standard deviation, and the data clustered around the mean or 4 and 5 from the 5-point Likert Scale suggest a higher acceptance rating of participants on "Ease of Use" as "easy" or "very easy," "Functionality" of tools used for effective learning as "good" or "very good," and "User Interface" of the learning environment as "good" or "very good."

The open-ended questions are purposely inserted into each construct to gather information to further give insights on refining the design setup. The participants generally gave positive feedback on the "Ease of Use," "Functionality," and "User Interface." In refining the design, negative responses were purposefully sought in the text analysis of participant's responses. On the "Ease of Use," participant 18 included a response to inform *"sometimes the video has no sound."* On "Functionality" participant nine informed *"the lecture video appears lagging at times"* and there was no further feedback given on "User Interface" to provide insights. Due to the response of the learner,

TABLE 1 | The mean and standard deviation of student's experience from pre-pilot test.

	Mean	SD
Ease of use	4.10	0.8310
Functionality	4.24	0.7822
User Interface	4.00	0.7138

TABLE 2 | The mean and standard deviation of student's experience from pilot test.

	Mean	SD
Ease of use	4.39	0.6077
Functionality	4.17	0.7432
Speed	4.17	0.8185
User Interface	4.33	0.7691

the learning technologists made an assumption that the speed of the internet may have contributed to the negative experience of the learners. Additional Wi-Fi hotspots were added in the area to ensure no disruption to the class being streamed synchronously to the online learners. Hence, a follow-up pilot test is run after some design refinement to the setup of the design of DEK with a different group of learners.

In the overall learning experience, participant 11 compared the experience from last semester when the class was conducted as an hybrid but using the temporary hybrid learning equipment (**Figure 5**) as *"It is easier to view the demonstration than last semester which requires someone holding the camera which is sometimes shaky."* Participant three compared the experience to indicate learning in DEK environment equipped with the Hybrid Learning facilities as better *"this year is better. I find it easier to study and listen to lecture."*

The subsequent pilot test was also performed in a small scale and 17 learners agreed to participate in the survey. The learners experienced learning in DEK for a semester and subsequently answered a survey with a 5-point Likert scale. All the participants' information was kept anonymous. The same constructs were measured as the pre-pilot; however, in the pilot test, "Speed" was added as one of the items to measure. The same constructs were measured as the pre-pilot, however, in the pilot test, 'Speed' was added as one of the items to measure. Referring to **Table 2**, the highest mean score is 'Ease of Use' (M 4.39), while both 'Functionality' and 'Speed' have the lowest score (M = 4.17). The average SD is 0.73462. The data spread from the histogram further shows a low standard deviation and the data clustered around the mean or four and five from the 5-point Likert Scale to suggest a higher acceptance rating of participants on the "Ease of Use' as "easy" or "very easy," "Functionality" of tools used for effective learning as "good" or "very good," and "User Interface" of the learning environment as "good" or "very good." On "Speed," the data is more spread out as compared with the other constructs; however, the neutral response at three does not indicate the participant is experiencing slow speed.

Generally, the participants gave a positive feedback on the "Ease of Use," "Functionality," "User Interface," and "Speed." The was no negative response to any of the constructs. On the "Ease of Use," participant 16 informed following the class from the online environment as *"It is not very complicated; everything has a label to state the use of it."* The experience of participant five indicated the ease of use because *"can adjust the speed by ourselves"*. On "Functionality," Participant five informed *"everything functions well for me, no technical issues,"* while Participant 11 informed the experience of "Functionality" is *"Smooth could easily fast forward."* On "User Interface," Participant four informed it is *"easy to understand even for someone new to the software,"* while Participant 14 informed, it is *"easy to understand and navigate."* On "Speed," Participant five informed: *"nothing is wrong and slow for me; it was fast to load everything"*. Whereas, Participant 13 on the other hand informed *"It is fast but wouldn't be as fast if it were face to face"*.

In the final open-ended question, unlike the pre-pilot test that asked for any other further comment for the pilot, the question was constructed to specifically ask the participant to compare their learning experience with their previous semester. A mixed review was given by the learners. However, most participants noticed an improvement in the way lessons were delivered in terms of audio and visual clarity, such as recording is clearer, cooking demonstration is clearly recorded, comparing last semester where lecturers shared similar videos from YouTube, and this semester they are able to view the course live with the on-campus students as Participant two stated *"live; online. Able to hear clearly"*. However, it is important to note, from the responses, the learners still prefer to attend this very practical-based class in the kitchen. Participant five informed because they are *"losing practical skills,"* and Participant four stated *"need to be able to cook in the kitchen"*.

DISCUSSION, IMPLICATION, AND CONCLUSION

The findings from the pre-pilot study indicate as an overall learning experience that learners can accept the hybrid learning setup as a temporary measure for class continuity, but some improvement could be made to the quality of the videos, for example, to reduce shaky video footage. Considering feedback from end-users of some discomfort due to the spartial gaps in learning for a practical-based classroom due to being online, some improvement was made to the design set-up in the DEK. The learner's feedback in the pilot indicates an overall better experience than the pre-pilot study after the learning is being conducted in the DEK equipped with hybrid learning facilities using the PTZ cameras instead of hand-held equipments, such as the gimbal or using a smartphone to stream videos. It was reported that learners have a preference for learning to be conducted as F2F compared to hybrid mode due to concerns about the very practical nature of the course. The socio-emotional learning process is somewhat hampered in an online classroom (Lathifah et al., 2020).

This DEK innovation was introduced to improve the socio-emotional learning process when the students' motivation was at an all-time low during the uncertainties of the COVID-19 pandemic. Although the pre-pilot and pilot study data are very small the findings gave useful information to gather students' acceptance of learning in the experimental stage of the Hybrid Learning mode, particularly for a classroom that is very practical in nature.

This pilot study insinuates positive impact can be obtained with the correct application of hybrid learning for practical classes with considerations on pedagogy and the course instructor's technique to ensure balancing activities between learners from the online and F2F. Secondly, the flexibility between study time and practical classroom which was unprecedented before could be adjusted according to the learner's abilities and their unique situations. As an example, when the F2F practical session starts, the Panopto system will automatically record the class in session so that the learners could review the class again at a later time or participate in the learning activities on the online platform at their own time. Thirdly, it reduces the tendency for learners to procrastinate on submitting assignments because a clear deadline is given in the learning platform. A deadline that is managed by the system increases the learner's self-awareness and trains them to become a more independent and self-directed learner. Finally, students' review was positive as they were able to interact with peers and instructor chefs in real-time as in the F2F classroom. This means that even though some students were coming from online mode, they were not isolated within that environment. All learners, irrespective of being online or F2F, were able to socialize and interact with their peers and instructors. This impact is positive because learning is a social activity, and even though learners are online, they were able to become familiar with the indirect interaction and socialization. This indicates that interaction and socialization could happen with others not just in a F2F setting but in different ways *via* online activities as well.

Contrarily, some obstacles were overcome within Taylor's eco-system to ensure the application of hybrid learning is successful. Firstly, learners' experience in the online mode for the synchronous practical demonstration session is highly dependent on the condition of the internet network. While the institution recognizes that they could only control the eco-system within Taylor's, learners' own internet network is beyond their control. Technical disruption due to unstable network causing screen time to freeze or course instructors or learners having to leave the Zoom session and re-enter becomes a norm that they have grown to accept and adapt with online learning. Recording the class in session and sharing the recording at a later time mitigates the issues with

technical disruptions during a synchronous session. Secondly, the course instructors must adapt to the new teaching method in designing their modules for the hybrid learning mode. The adaption to managing a classroom in both F2F and online could be a challenge for some lecturers. A new teaching curriculum with flexible activities to replace what students normally do during the F2F class ensures student learning time is achieved within the Malaysian Qualifications Agency (MQA) standards. This includes a redesign of activities that includes techniques, assignments, and evaluations. Hence, research to investigate the course instructors' experience will provide an insight into managing a hybrid learning classroom. The learning conducted in the DEK will continue to be monitored closely for improvement based on the end-users feedback. Situations like COVID-19 may occur in the future, and learning as a hybrid mode has become a new norm for education today. For the study to be more meaningful, a follow-up or a long-term study can be conducted with more end-users experience from both learners as well as the course instructors as they deal with the spartial gaps as learning approach has shifted to the hybrid learning pedagogies post-COVID.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

Ethical review and approval was not required for the current study in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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Malaysian dental deans' consensus on impact of COVID-19 and recommendations for sustaining quality dental education

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The COVID-19 pandemic has significantly affected the training of dental students and the impact can be felt not just by the students, but patients seen at dental school operated clinics. We used the modified-Delphi method to investigate the response from deans of all Malaysian dental schools on the impact of COVID-19, and to solicit their views on policy recommendations to sustain quality dental education during and beyond the infectious disease outbreak. Our analysis revealed that all dental deans are in agreement with strong consensus to 10 out of fifteen items listed to be the challenges they faced due to the COVID-19 pandemic particularly these three items: "Patients under care of students experienced interrupted dental treatment which increases their risk of having their dental and overall wellbeing affected"; "Increased clinical budget for daily operations of Students' clinics to cater for extra PPE and related expenses," and; "The Students' ability to meet clinical requirements for safe and competent practice." All deans agreed with a strong consensus to the policy statements formulated based on the WHO's Six Building Blocks to sustain quality dental education. In view of the results, we further discussed the importance of acknowledging that university-led dental clinics as an important part of the national healthcare system. Hence, we proposed that dental education need to have clear policies on having adequate number of trained staff, sufficient funds, information, supplies, transport, communications and overall guidance, and direction to function. Having a National Dental Education Policy that addresses the unique challenges identified in this study will serve as a monumental cornerstone to sustain quality dental education during times of calamity.

KEYWORDS

COVID-19, dental education, modified-delphi technique, WHO's Six Building Blocks, health care system

Introduction

The COVID-19 pandemic, resulting from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has caused widespread infections with extreme consequences. The outbreak received global attention in December 2019 and was recognized as a pandemic of major public health concern by the World Health organization (WHO) on the 11th of March 2020 (WHO, 2020). Sadly, even after more than 2 years and despite the uptake of vaccination in most countries, the pandemic is not yet showing any sign of being contained soon. The appearance of new variants which cause the infected individuals to exhibit a spectrum of diverse reactions and symptoms severity adds to the challenge for policy-makers to optimize the use of resources in mitigating the disease (Boehm et al., 2021; Araf et al., 2022; Mistry et al., 2022).

The main transmission of SARS-CoV-2 virus among individuals is through respiratory droplet and direct contact with the individual with positive COVID-19. Social distancing is almost impossible in dentistry and with high amounts of aerosol generated during dental procedures, dental practitioners are at high risk of contracting or transmitting COVID-19 (Izzetti et al., 2020). There is a high COVID-19 inhalation transmission risk on execution of dental procedures with usage of handpieces, that causes aerosolization of the blood, saliva and bodily secretions (Meng et al., 2020).

Due to COVID-19, universities had adapted their curriculum delivery by moving teaching and learning activities to online platforms (Kerkstra et al., 2022). However, dental schools are not only educational and research institutions but also small hospitals and operational entities with high infrastructural and operational costs. They make an important contribution to the health and wellbeing of the population providing oral health care services. As such, unlike other courses, the dental curriculum requires students to undergo clinical training face to face, and this component of their teaching and learning had been interrupted during the early onset of the pandemic due to the high risk of virus transmission during clinical encounters. During the early phase, it should be noted that that the enhanced clinical protocol for cross infection control was not yet available, and neither was COVID-19 vaccination and self-test kits. Moreover, during the COVID-19 pandemic, series of Movement Control Orders (MCO) were imposed in Malaysia affecting parts or all of the country depending on the severity of the situation. These orders include instructions to close universities or only online teaching and learning were allowed, causing major disruptions to the clinical training (Ross, 2021).

For dental school administrators in Malaysia, it has been necessary to modify some aspects of the cross-infection control protocols and to make adaptations to the guidelines' recommendations provided by the Ministry of Health (Oral Health Division Ministry of Health Malaysia, 2020a,b) for use

at Students' clinics. This is important so that clinical training of dental students may be resumed albeit conducted in the light of the "new norms." New norms such as reduced hours each student spends in clinical sessions and low patient attendance due to enhanced clinical protocols, movement control order and fear of dental clinic exposure will have an impact on the clinical competency of graduating dentists because these students will see fewer patients. Many dental schools had to resort to delaying graduation by prolonging the academic semesters to ensure that students are safe and competent to practice. Studying the response of dental school administrators provides decision-makers with an insight on what are the challenges faced by dental schools to sustain quality dental education and to provide safe dental services for the public served by university dental clinics. The aim of this study was to investigate how the COVID-19 pandemic has impacted the Malaysian dental schools, and to solicit the views on policy recommendations to sustain quality dental education during and beyond the infectious disease outbreak from the leaders of the Malaysian dental schools.

Materials and methods

Study design

This is a nation-wide, cross-sectional study involving dental school deans which employed an online modified two-rounds Delphi survey method of data collection (Waggoner et al., 2016; Jünger et al., 2017). We modified the survey by asking the participants to rate their agreement on the pandemic-related issues impacting dental education synthesized from published literatures, instead of making the questions open-ended. We provided space for participants to state any other issues or comments if they had additional concerns.

Sample

There are thirteen dental schools in Malaysia comprising six from the public sector and seven from the private sector. In view of their capacity as leaders of dental schools, we invited all deans to participate in this study.

Study instrument

We developed the questionnaire consisting of two parts. Part A (Table 1) consists of statements related to the impacts of the COVID-10 pandemic on various aspects of dental schools. We started the literature search by searching Google Scholar and PubMed using the keywords "dental/dentistry," "school/university/faculty/academia/students," and "Corona-

TABLE 1 Impact statement of COVID-19 on dental undergraduate training.

		The COVID-19 pandemic has
Teaching and learning (theory/clinical training/patient care)	T1	Affected the Students' ability to meet clinical requirements for safe and competent practice
	T2	Caused the lecturers to be unprepared or less prepared to deliver effective online teaching to accommodate the need to conduct emergency remote teaching
	T3	Caused some concern over the possibility of Students' cheating when examinations are conducted using online platform
	T4	Caused patients under care of students to experience interrupted dental treatment which increases their risk of having their dental and overall wellbeing affected (by the postponement of dental care).
	T5	Caused the faculty difficulties to accommodate adequate space for physical distancing during learning sessions in lecture halls, seminar rooms, clinics and laboratories.
	T6	Caused difficulty to contain spread of aerosol in multi-cubicle layouts in Students' clinics
	T7	Caused interruptions to classes because of unstable internet connection that does not facilitate online teaching and learning sufficiently.
	T8	Caused interruptions to classes because there is inadequate ICT[a] equipment at the faculty to facilitate online teaching and learning sufficiently
	T9	Caused the need to increase clinical budget for daily operations of Students' clinics to cater for extra PPE[b] and related expenses
	T10	Caused the need to allocate adequate budget for the renovation of building or learning space to accommodate infection control COVID-19 SOP[c] (e.g., physical distancing, need for more open spaces, need to isolate clinical work spaces).
	T11	Caused disruptions in scheduling and planning of teaching and learning sessions because of the changing guidelines/regulations/SOPs at national level (MKN[d]/KKM[e] etc.)
Psychology/Emotion	P1	Caused students to be afraid and anxious about the probability of getting infected during clinical sessions and infecting friends and families.
	P2	Caused the students to feel socially isolated due to the need for distancing and limiting (physical) social activities
	P3	Caused the students to lose their motivation in learning because of less interaction with lecturers/friends during online classes
	P4	Caused anxiety among the clinical support staff because of the need to adapt to new norms in the clinics

[a]Information and Communication Technology, [b]Personal Protective Equipment, [c]Standard operating procedure, [d]Majlis Keselamatan Negara (National Security Council), [e]Kementerian Kesihatan Malaysia (Ministry of Health Malaysia).

virus/Covid-19/Covid19/Sars-cov-2" for articles published up till 30th November 2020. A total of 143 articles was found. For each manuscript, preliminary relevance to the study scope was determined by its title. If the content seemed related to Covid-19 and dental education from the title, we obtained its full reference, including author, year, title, and abstract, for further evaluation.

After initial screening of the titles, a total of 47 studies were deemed relevant and we obtained the full-text article for quality assessment. We included studies that analyzed the impacts and challenges of Covid-19 to dental undergraduate educations. Whereas articles that were not original, study on other viruses or not related to dentistry were excluded. A total of seven studies were excluded after careful review: two were excluded because they did not focus on undergraduate education; three were excluded for the following reasons: not about dental education, a personal opinion and was not Covid-19 related. Overall, forty studies from the initial search were included for extraction of themes to be used in developing the questionnaire.

The final questionnaire used in Part A had a total of fifteen statements related to impacts of COVID-19 on dental education and training in the dental school's environment. The respondents were required to rank the impact level of each

statement based on their opinions on a 5-point Likert scale ranging from "minimal" to "severe."

Part B (Table 2) consists of six policy recommendation statements based on the WHO Health Systems Framework: Six Building Blocks (WHO, 2007) where the respondents were required to rank their agreement on each statement on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree."

We prepared the questionnaire form to be used as an online form and pre-tested it on eight senior clinical academics. The feedback from the pre-test was used to improve the clarity, ease of making responses, and the overall format of the questionnaire.

Data collection

We emailed the invitation to all deans of the thirteen dental schools across Malaysia. The invitation letter was accompanied by details of the study and an informed consent form for the deans to fill up if they agree to participate in the study. In the first round of the Delphi survey, participants would indicate their scores on each statement formulated for both Parts A and B, based on the Likert scales via the pre-tested online questionnaire. They submitted the answers within 4 weeks upon

TABLE 2 Policy recommendation statements.

There must be a policy to ensure	WHO six building blocks
1 The delivery of effective, safe, and quality dental services to patients, when and where needed, with minimum waste of resources.	Service delivery
2 That there are sufficient academic staff, as well as administrative and clinical support staff, fairly distributed; and that they are competent, responsive, productive, and protected.	Health workforce
3 That a Dental Health Information System is in place to enable the production, analysis, dissemination and use of reliable and timely information on health determinants, health system performance and oral/general health status.	Health information systems
4 Clinical teaching and dental services are provided essential materials of assured quality, safety, efficacy and cost-effectiveness, and their scientifically sound and cost-effective use.	Access to essential materials and supplies
5 That there are adequate funds for the operations of clinical dental training and to provide essential dental services to patients.	Financing
6 Strategic policy frameworks exist and are combined with effective oversight, coalition building, regulation, attention to system-design, and accountability.	Leadership/Governance

receiving the online questionnaire. Qualitative comments were collected for each statement and analysis of the comments was done by the research team. Any new issues suggested by the participants in Round One would be carried forward to Round Two. The researchers then summarized these scores and used them to formulate the second round of the Delphi survey.

In the second round, each participant was given the median group score of each of the statement which they had earlier ranked, alongside their own score. They were asked if they wished to change their score or keep their original score. The deans were also given the opportunity to add comments to their responses. The second round of the data collection was completed within 2 weeks.

The anonymity of the participants was maintained in both rounds. The participants involved only had the access to their own answers and the group's median score from the first round. Only the researchers had the access to each participant's answers and personal details.

Data analysis

Responses from the online form were exported to Microsoft Excel, and descriptive statistics were reported using the median Likert scores, and consensus score (%) for each item. The response for Likert Scale of 3–5 was counted as agreement to the statement and the percentage of agreement for each statement was calculated. Consensus was defined *a priori* as weak (less than

65% agreement), moderate (65–79% agreement), and strong (80% or more agreement) (Engelman et al., 2018).

Results

Twelve deans out of thirteen dental schools participated in both rounds of the modified Delphi survey (92.3% response rate), out of which five were public and seven were privately funded dental schools. Table 3 summarizes the round one and round two survey results of the deans' consensus on the impact and challenges of the COVID-19 pandemic on dental education.

The percentage of consensus for seven items increased while one item saw a slight decrease in the percentage of consensus at the second round of the survey. Overall, the deans agreed with strong consensus to 10 out of fifteen items listed to be the challenges they faced due to the COVID-19 pandemic. The only item that had a median score of less than 3 denoting disagreement of the item being a challenge was regarding COVID-19 causing interruptions to classes due to inadequate ICT equipment at the faculty to facilitate online teaching and learning sufficiently. However, the consensus among the deans was weak for this item (50.0%).

There is also a notable difference in the strength of consensus for the items listed between public and private dental school deans where the public dental school deans reached strong consensus for thirteen items compared to eight items among the private dental school deans. Nevertheless, all deans unanimously agreed with high median scores for these three statements: (T4) The COVID-19 pandemic has caused the patients under care of students to experience interrupted dental treatment which increases their risk of having their dental and overall wellbeing affected (by the postponement of dental care); (T10) The COVID-19 pandemic has caused the need to increase clinical budget for daily operations of Students' clinics to cater for extra PPE and related expenses, and; (T1) The COVID-19 pandemic has affected the students' ability to meet clinical requirements for safe and competent practice.

Table 4 summarizes the deans' agreement on items related to policies needed for dental education for round one and round two of the survey. The median score for all statements was between 4.5 and 5 with strong level of consensus. No change of opinion was noted between round two and round one for this section.

Some deans also took the opportunity to add comments with regards to the challenges faced and policies needed to counter the impact brought by COVID-19 on the country's dental education. All comments provided by the deans were scrutinized and found to be emphasizing the existing statements and so they were not added as new issues in the second round of the survey.

TABLE 3 Consensus on impacts of COVID-19 pandemic on dental education.

Statement	Round	Total (n = 12)			Public (n = 5)			Private (n = 7)		
		Median score (1–5)	Consensus		Median score (1–5)	Consensus		Median score (1–5)	Consensus	
			%	Strength		%	Strength		%	Strength
T1	1	4.0	100.0	Strong	4.0	100.0	Strong	4.0	100.0	Strong
	2	4.0	100.0	Strong	4.0	100.0	Strong	4.0	100.0	Strong
T2	1	3.0	58.3	Weak	3.0	80.0	Strong	2.0	42.9	Weak
	2	3.0	66.7	**Moderate**[a]	3.0	80.0	Strong	3.0	57.1	Weak[a]
T3	1	3.5	66.7	Moderate	4.0	60.0	Weak	3.0	71.4	Moderate
	2	3.5	75.0	Moderate[a]	4.0	60.0	Weak	3.0	85.7	**Strong**[a]
T4	1	4.5	100.0	Strong	4.0	100.0	Strong	5.0	100.0	Strong
	2	5.0	100.0	Strong	4.0	100.0	Strong	5.0	100.0	Strong
T5	1	3.5	91.7	Strong	4.0	100.0	Strong	3.0	85.7	Strong
	2	3.0	100.0	Strong[a]	4.0	100.0	Strong	3.0	100.0	Strong[a]
T6	1	4.0	91.7	Strong	4.0	100.0	Strong	5.0	85.7	Strong
	2	4.0	83.3	Strong[b]	4.0	100.0	Strong	4.0	71.4	**Moderate**[b]
T7	1	3.0	75.0	Moderate	3.0	100.0	Strong	3.0	57.1	Weak
	2	3.0	83.3	**Strong**[a]	3.0	100.0	Strong	3.0	71.4	**Moderate**[a]
T8	1	2.5	50.0	Weak	3.0	60.0	Weak	2.0	42.9	Weak
	2	2.5	50.0	Weak	3.0	60.0	Weak	2.0	42.9	Weak
T9	1	4.5	91.7	Strong	5.0	100.0	Strong	4.0	85.7	Strong
	2	4.0	91.7	Strong	5.0	100.0	Strong	4.0	85.7	Strong
T10	1	4.0	91.7	Strong	5.0	100.0	Strong	3.0	85.7	Strong
	2	4.0	100.0	Strong[a]	5.0	100.0	Strong	3.0	100.0	Strong[a]
T11	1	4.5	91.7	Strong	4.0	100.0	Strong	5.0	85.7	Strong
	2	4.0	91.7	Strong	4.0	100.0	Strong	4.0	85.7	Strong
P1	1	3.0	66.7	Moderate	4.0	100.0	Strong	2.0	42.9	Weak
	2	3.0	66.7	Moderate	4.0	100.0	Strong	2.0	42.9	Weak
P2	1	3.0	66.7	Moderate	3.0	80.0	Strong	3.0	57.1	Weak
	2	3.0	75.0	Moderate[a]	3.0	100.0	Strong[a]	3.0	57.1	Weak
P3	1	3.0	75.0	Moderate	3.0	80.0	Strong	3.0	71.4	Moderate
	2	3.0	83.3	**Strong**[a]	3.0	80.0	Strong	3.0	85.7	**Strong**[a]
P4	1	3.0	83.3	Strong	4.0	100.0	Strong	3.0	71.4	Moderate
	2	3.0	83.3	Strong	4.0	100.0	Strong	3.0	71.4	Moderate

[a]Increase in percentage of consensus, [b]Decrease in percentage of consensus, Bold denotes increase in level of consensus strength.

> "Emotional support for the students and staff during this challenging time." Dean-2

> "Policy on the need for all dental clinics including private to employ officially trained clinical support staffs." Dean-5

> "The decision to close down operations of colleges and universities should be done with pragmatic approach, keeping a distinction between health professional institution and other programs. The actual impact of this year's policy of MCO (Movement Control Order) will be borne by the future cohorts of students who are in their junior years and have not had the required clinical exposure thus leading to extension of their training. Also, a more flexi policy in terms of staff numbers, SLT management, regulating MCE/ECE (Minimum Clinical Exposure/Expected Clinical Exposure) etc. should be allowed for dental institutions for the next 2–3 years because the covid-19 pandemic impact has manifold ramification in the years ahead. This should be borne in mind especially when accreditation assessment." Dean-6

> "Relook into the Malaysian: expatriate staff ratio as it is very challenging to get clinicians in few regions of the country." Dean-9

TABLE 4 Consensus on dental education policy statements to sustain safe and effective delivery of the curriculum based on the WHO Six Building Blocks.

Statement	Round	Total (n = 12)			Public dental school (n = 5)			Private dental school (n = 7)		
		Median score (1–5)	Consensus		Median score (1–5)	Consensus		Median score (1–5)	Consensus	
			%	Strength		%	Strength		%	Strength
1	1	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
	2	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
2	1	5.0	91.7	Strong	5.0	100.0	Strong	5.0	85.7	Strong
	2	5.0	91.7	Strong	5.0	100.0	Strong	5.0	85.7	Strong
3	1	4.5	100.0	Strong	5.0	100.0	Strong	4.0	100.0	Strong
	2	4.5	100.0	Strong	5.0	100.0	Strong	4.0	100.0	Strong
4	1	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
	2	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
5	1	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
	2	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
6	1	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong
	2	5.0	100.0	Strong	5.0	100.0	Strong	5.0	100.0	Strong

"In making demands to ensure quality and quantity, any policy created should be an equitable and fair one able to be met by both public and private universities. It is unfair to expect every single equipment in a private university must equate to public universities more so if the university is still young and groping. However, academic staff's quality should not be compromised but again a fairer system should be discussed. Imposition of policies based on a so-called benchmark university will not help a young and new institution." Dean-11

"Additionally, the uncontrolled increase in the price of these PPE, availability and excessive use and additionally PPE required due to enhanced infection control protocol, made the budgeting very challenging." Dean-9

Discussion

Our study employed the modified Delphi method which is in line with the recommendations of past studies (Waggoner et al., 2016; Jünger et al., 2017). The Delphi technique was developed in the 1950s by The Rand Corporation scientists and has become increasingly used as a method for developing consensual guidance on best practice. Instead of starting the round with an open-ended questionnaire, our first round was modified by asking the participants to rank items synthesized from published literature. This modification was implemented to ensure a solid grounding in the existing evidence regarding the issue discussed. Additionally, the strength of the modified Delphi technique used lies in the anonymity of the participants as well as controlled feedback that is believed to reduce the effect of bias due to group interaction (Custer et al., 1999).

The main issue with dental education and training is that university-led dental clinics are rarely seen as core to the national healthcare system because of the widespread perception that universities are for teaching and research only. Unless one has received treatment at a university dental clinic, most people are unaware that the bulk of the dental services at these clinics are provided by dental students. These existing shortcomings are further magnified by the restrictions imposed because of the pandemic. In dental school settings, dental faculty administrators have opted to make adaptations to the COVID-19 guidelines recommendation that were originally developed by the Ministry of Health for use at the various public and private sector dental clinics during and potentially beyond the pandemic.

Due to the different physical set-up of dental school clinics and the nature of patient flow in the clinical training environment, some of the measures in the original guidelines are not implementable. Furthermore, these adaptations would vary according to the unique dental school settings and geographical locations that may be affected by local authorities standard operating procedures. The adaptations of the original guidelines and ongoing uncertainties about the containment of the COVID-19 pandemic raises a concern whether dental students are able to continue their training to be safe and competent dentists. Subsequently, will universities be able to provide adequate resources to sustain safe and quality dental education and

training amidst the uncertainties of this malicious disease outbreak?

Challenges and impact of COVID-19 on dental education

COVID-19 pandemic in Malaysia has caused interruptions to higher education from the first MCO issued. This had resulted in disruptions to teaching and learning activities of dental students as agreed unanimously by the deans of Malaysian dental school from this study and confirms that Malaysian dental schools experienced similar challenges reported worldwide (Gurgel et al., 2020; Peres et al., 2020; Quinn et al., 2020; Wang et al., 2021) such as limitation of face-to-face teaching and learning activities, and disrupted clinical training. Due to the limitation of face-to-face classes, all universities have adapted to the emergency remote teaching. However, not all components could be delivered via this method (Elangovan et al., 2020; Saeed et al., 2020).

In Malaysia, dental graduates are deemed as competent to fully register and serve as dentists with the Ministry of Health upon graduation as opposed to their medical counterpart who need to undergo houseman-ship for a minimum of 2 years. It is therefore imperative for all dental schools to ensure their graduating students have achieved the required competencies to serve as dentists independently. And this requires face to face clinical training. Another problem with remote teaching is it deepens the issue with inequalities where students from the lower socio-economic background were reported to have difficulties accessing remote lessons (Hill and Lawton, 2018; Zilka et al., 2021).

It is clear from our findings that the COVID-19 has impacted the training of dental students in Malaysia. Other surveys addressing the Malaysian dental students also reported similar sentiments (Lestari et al., 2022; Pandarathodiyil et al., 2022). Disrupted clinical training leads not just the difficulty in ensuring graduate competencies, it also affects the psychological and emotional state of the students, and leads to another major concern which was the disruption of continuity of care that would be detrimental for the oral health of their patients (Al-Omiri et al., 2021; Nguyen et al., 2021). Untreated oral diseases, resulting in preventable pain, infection and reduced quality of life, can lead to productivity losses such as missed schooling or work.

The clinical training of dental students in Malaysia was suspended intermittently for almost a year since 2020. These missed clinical sessions, if not replaced, will mean that students risk not getting the training and competencies required to graduate. The decision to suspend operations of colleges and universities should therefore be done with pragmatic approach, keeping a distinction between health professional institution and other programs. The dental faculty fraternity are at a higher

risk to be infested with any blood-borne or fluid-borne (droplets and splatters) infectious disease due to close patient contact in the clinic environment. With a specific policy, concerns for their health and safety can be made a priority with regards to sufficient protective measures like personal protective equipment (PPE) and vaccination, as well as effective work from home measures to reduce unnecessary crowding at the workplace. Support for mental and emotional health of the dental faculty fraternity must also be in place because fear, anxiety and burnout are rife during these difficult times (Shacham et al., 2020; Uhlen et al., 2021). These policies will give autonomy to faculty administrators to make quick decisions regarding these matters and not strictly bounded by blanket practices in other faculties.

Recommendation for sustaining quality dental education

Acknowledging the challenges brought forth by the COVID-19 pandemic, current research proposed six policy statements based on the World Health Organization (WHO) Six Building Blocks of Health System Framework (WHO, 2007) to cover the areas needed for dental schools to sustain quality dental education even in the midst of infectious disease outbreaks or other situations of national crisis. The Six Building Blocks of Health Systems Framework describes health systems in terms of six building blocks namely service delivery, health workforce, health system information, essential materials and supplies, health financing, and leadership/governance. Each block holds equal importance in ensuring smooth running of a healthcare system.

Service delivery

When university-led dental clinics are not considered as core to the national healthcare system (Ahmad et al., 2020), they risk being under-funded when the given operating budget does not match the needs to run not only a teaching and research institution, but clinics providing treatment for real patients. Sustainable policies to help maneuver challenges faced in running dental schools not just based on their existence as training institutions but as part of the healthcare system are needed now more than ever.

Health workforce

In Malaysia, there is an apparent imbalance in the number of local against international academic manpower between public and private dental schools. Supported by the government fundings, public dental schools manage to implement recommended strategies (Corbet et al., 2008) such as competitive pay scale and better career advancement prospect; opportunities for sponsored postgraduate studies; and the chance to opt for an attractive retirement scheme. However, private dental schools are not able to offer similar benefits

making it difficult for them to recruit local academics as commented by one of the dental deans. This discrepancy in human resource policy is an added challenge to the private institutions in recruiting and retaining clinical dental educators.

The ability of a dental faculty to meet its training, research and service goals depends largely on the knowledge, skills, motivation, and deployment of the people responsible for organizing and executing these tasks. Difficulty in securing a good number of human resources needed to deliver essential tasks including health services could be due to a number of reasons, for example location of the university or the inability to recruit qualified personnel (Godwin et al., 2014).

Seven out of 12 dental schools involved in this study are located in and around Kuala Lumpur, the capital city of Malaysia. For these schools, recruiting and retaining qualified personnel may not be as challenging as the schools located far away from the capital city. Dental education policies need to factor in the human resource challenges and relevant strategies such as more attractive renumeration to ensure core activities of the dental schools are not affected. The uniqueness of the dental school workforce should be given its due recognition because of the dual duties assumed in delivering training as well as dental services to the public.

Health information system

Sound information on the availability of human resource is needed to formulate a policy in pursuit of human resources to operate a dental school. Sound and reliable information also plays a vital role in making important decisions pertaining to health service delivery, research and training which are also the core components of a dental school. Hence, all dental schools should have a policy that supports the collection, analysis and management of health-related information in order to ensure successful monitoring and evaluation of training and service delivery.

It would be desirable that there is digital sharing of information between institutions to allow a larger pool of data to be generated and analyzed for better health and training needs decision-making, provided all precautionary measures are taken to ensure sensitive and personal data of patients and institutions are duly protected. This initiative would be in tandem with the aspirations of the Ministry of Health to achieve a seamless level of patient information services and systems and enhance the effectiveness of health services in terms of holistic patient care and management.

One of the major impacts of the COVID-19 pandemic of COVID-19 on the oral healthcare delivery is the reduced face-to-face consultation and the risk of infection during the delivery of aerosol generating procedure (AGP). Thus, it is worthwhile that investments in digital technology for tele-dentistry initiatives be considered, and this is in fact would be in line with the rise in patient expectation and consumerism (Loh et al., 2020; Patel and Wong, 2020; Menhadji et al., 2021).

Essential materials and supplies

The Malaysian dental deans also strongly agreed on the need for a policy guaranteed essential materials of assured quality, safety, efficacy, and cost-effectiveness, and their scientifically sound and cost-effective use for clinical teaching and dental services provided. One of the deans in the free comment section also noted that the prize of essential materials and supplies for clinical training and teaching need to be controlled. A well-functioning health system ensures equitable access to safe and effective materials and supplies essential for operation (WHO, 2010).

Just like other building blocks-related statements, the policy to monitor access to essential materials and supplies is closely intertwined with other building blocks. When essential materials and supplies are not secured, the service delivery will also be disrupted hence, weakening the health system. Therefore, essential materials and supplies for dental schools need to be made available within the context of functioning health systems at all times, in appropriate amount, with good quality, and at a controlled and affordable price.

Health system financing

Health financing is an essential part to maintain and improve health system. Without funds it is not possible to employ health workers nor procure essential materials and supplies as well as many other activities within the system. Malaysia was successful at achieving near-universal access to public sector healthcare at low cost with a huge portion of the healthcare financing absorbed by the government. The cost that needs to be absorbed by the government continues to increase and better health system financing has been discussed and proposed many times by experts from various backgrounds at national level. However, it is a challenge that need to be handled with care considering Malaysian policymakers feared for their political survival which made them refrain from implementing reforms to current policy especially when the Malaysian public is generally resistant to any change that might require them to pay even a small amount to contribute to the health financing mechanism (Croke et al., 2019).

COVID-19 has caused a significant impact on the financial aspects of the running of the dental schools. Dental schools in Malaysia belong to the Ministry of Higher Education and have limited autonomy in how they manage their funds. Proper consideration unique to dental schools is needed to maintain universal coverage that allows access to health services without the risk of a financial catastrophe to patients and the institution.

Leadership and governance

Governance in health is an integral part of the health system components and intimately connected with accountability. Leading and governing dental schools require great accountability to produce results from the fundings received. Accountability is therefore an important aspect of governance

that concerns the management of health service delivery, training, and research activities in dental schools. Strong and effective leadership is a compulsory trait for dental academia leaders to succeed (Verma et al., 2019) amidst the challenges discussed in this paper.

There is currently no National Dental Education Policy, and hence there is no over-arching guidance document that unites the dental educators, and merges dental education and training with other dental agencies and stakeholders in achieving the overall quality of life direction for Malaysians. To be able to create a policy framework to address issues and challenges faced by the dental education sector is timely now as Malaysia aims to achieve the Sustainable Development Goals and specifically the National Oral Health Plan for Malaysia 2030 agenda in the era of post COVID-19 pandemic.

In view of the deans' consensus on the impacts of COVID-19 and the policy statements for sustainable dental education, this study proposed that the policy on dental education should ensure that the following six deliverables are supported:

1. Delivery of effective, safe, and quality dental services to patients at the faculty clinics, when and where needed, with minimum waste of resources.
2. There are sufficient academic staff, as well as administrative and clinical support staff at the faculty, type and numbers fairly distributed across the departments; and that they are competent, responsive, productive, and protected.
3. A Dental Health Information System is in place to enable the production, analysis, dissemination, and use of reliable and timely information on health determinants, health system performance, and oral/general health status of the patients.
4. Clinical teaching and dental services are provided essential materials of assured quality, safety, efficacy, and cost-effectiveness, and their scientifically sound and cost-effective use.
5. Adequate funds for the operations of clinical dental training and to provide essential dental services to patients.
6. Strategic policy frameworks exist for teaching and learning activities for dental students, including dental services operations, and that these frameworks are combined with effective oversight of strong faculty leadership, coalition building with stakeholders (e.g., Ministry of Higher Education, Ministry of Health, Ministry of Defense), regulation, attention to system-design and accountability in decision-making.

Limitation of the study

Studies using the modified Delphi method may not achieve the same results as other methods to achieve consensus that employ face to face or online synchronous discussion. The lack of interactions between participants may have hampered the process of producing and assessing new ideas which was evident in the lack of new relevant issues provided by the participants in our study. Further, the statements used to achieve the consensus were synthesized from studies published during the early phase of the pandemic and may not reflect issues faced at a later phase. Nonetheless, the opportunity to add other statements had been given to the participants in the open-ended sections of the survey questionnaire.

Despite the absence of validated quality parameters to evaluate Delphi studies (Nasa et al., 2021) we took great care to ensure the methods used in our study observed the following recommendations: Experts recruited are defined and the method of recruitment is explained; Anonymity of participants are ensured; Iterative discussions with controlled feedback is employed; Consensus is defined; Statistical evaluation is described (Jünger et al., 2017; Engelman et al., 2018; Nasa et al., 2021).

Conclusion

The COVID-19 pandemic has further magnified the existing shortcomings faced by the dental schools and is expected to have manifold ramification in the years ahead. Accepting that dental schools are part of the health system acknowledges their need to have clear policies on having adequate number of trained staff, sufficient funds, information, supplies, transport, communications, and overall guidance and direction to function. Having a National Dental Education Policy that addresses the unique challenges identified in this study will serve as a monumental cornerstone to sustain quality dental education during times of calamity.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

This study was reviewed and approved by the Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM PPI/111/8/JEP-2020-690). The participants provided their written informed consent to participate in this study.

Author contributions

TM-D, KL, HR, and HY involved in the design of the study and contributed to the review of literature. KL collected the data. KL, TM-D, and HR conducted analyses. HR and TM-D wrote the first draft of the manuscript, after which KL and HY read and critically revised. All authors have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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Conflict of interest

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

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