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Factors for Sustainable Online Learning in Higher Education during the COVID-19 Pandemic

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Abstract: The coronavirus disease 2019 (COVID-19) pandemic has affected educational institutions and instructors in an unprecedented way. The majority of educational establishments were forced to take their courses online within a very short period of time, and both instructors and students had to learn to navigate the digital array of courses without much training. Our study examined factors that affect students' attitude toward online teaching and learning during the COVID-19 pandemic. It is different from other online learning studies where online courses are mostly a method of choice, with suitable support from institutions and expectation from instructors and students, rather than a contingency. Under this specific environment, we utilized an online survey to collect students' feedback from eleven universities across Hong Kong. Using partial least squares for analysis on the 400 valid samples we received, we found that peer interactions and course design have the most salient impact on students' attitude, whereas interactions with instructors has no effect at all on students' attitude. Furthermore, we also provide suggestions on using the existing technologies purchased during COVID-19 for a more sustainable learning environment going forward.

Keywords: COVID-19; learning outcome; motivation; online learning environment; satisfaction; self-determination theory; students' attitude

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1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has had a severe impact on educational institutions worldwide, leading to the near-total closures of schools, colleges and universities [1]. Education is important to the development of individuals and the sustainability of the society. In order to maintain continuous and effective education, many educational institutions have started to switch their teaching mode to online teaching during the COVID-19 pandemic [2]. For the sustainable online learning, students' attitude toward online learning and their interest of learning should be considered because online classes may replace classroom learning for a long period of time. In addition, the COVID-19 pandemic has created a new revolution in education. We may expect more online elements of education to emerge even after COVID-19 has passed.

Many courses, at all different levels of education, have had to suddenly switch from classroom teaching mode to online teaching mode [1]. However, the majority of teaching faculties have no previous online teaching experience, nor are they familiar with the technical tools that must be used to deliver lectures online [3]. Moreover, many educational institutions might not be well-equipped to facilitate online teaching with information technology such as virtual classroom software [4]. Some researchers argued that online teaching is similar to teaching in classroom and the role of the online instructor is similar to a faculty teaching in classroom [5]. However, more recent studies show that the skill and focus of online instructors are different from instructors in classroom. Online instructors

need the knowledge, skills and ability to manage the online teaching system and engage students through virtual communication. Lichoro [6] found that instructors do not feel adequately prepared and competence enough to teach online. Downing and Dyment [7] examined instructors' readiness and preparation for, as well as their perceptions of, preparing pre-service instructors in a fully online environment. They found that instructors considered online teaching time-consuming.

Previous research has been mainly focusing on the Critical Success Factors (CSFs) of e-learning for experienced online teaching instructors. Regrettably, fewer work has been done on CSFs for instructors with little or no online teaching experience. Several predictors [8,9] of user satisfaction and learning outcomes in the university online teaching have been examined including course structure, instructor feedback, self-motivation, learning style, interaction and instructor knowledge. However, the samples of these research works were collected from the students who attended online courses delivered through the online program of universities and thus they have already expected online learning. The instructors of these online courses are much better equipped with digital delivery than the majority of the instructors who have to deliver online teaching during this COVID-19 crisis. Even more importantly, little work has been done on the learning attitude of students and how it can be impacted by factors which the instructors could control and manipulate. COVID-19 provided us with an opportunity to study students who have experienced both classroom and, now, online learning that previous researchers were not able to study. Therefore, the primary objective of this research was to identify if there is a change of university students' learning attitude during the period of online delivery, and if their experience in the online environment could impact their overall interest in learning during the COVID-19 pandemic.

In the next sections, we discuss the theoretical framework of our research model, followed by the methodology employed, and the discussion of the results with conclusions.

2. Theoretical Background and Hypotheses

Student satisfaction and perceived learning outcomes have become popular measures of the quality of education [10]. Our research model postulates that students' attitude toward learning could be impacted by their perceived learning outcome, as well as their perceived satisfaction in the online environment. When students are contented with their learning outcome, it gives them a sense of achievement and heighten sense of competence which in turns, based on self-determination theory, enhances their motivation and engagement [11], thus altering their intention and attitude [12,13]. Moreover, our research model measures the relatedness of students' involvements with other students and their instructors. Self-determination theory, which studies human motivation and personality in social context [14], also suggests that human interaction is one of the basic needs that could have a profound impact on their sense of self and attitude. It has been proposed that self-determination theory could be used as a theoretical framework to integrate issues in online learning [15].

Our choice of variables is based on the most common constructs used in a vast array of practices and standards for online teaching with multitude dimensions. Some of these practices are derived from theory and models of online learning; on the other hand, some applied existing learning theories to the online settings. Among them, the common practices related to students' satisfactions and perceived learning outcomes are (1) interaction, (2) facilitation, and (3) course design. Eom and Ashill [8] extracted three learning models from the literature and defined the characteristics of online courses. The three learning models are constructivist model for learning [16,17], virtual learning environment (VLE) [18] effectiveness model, and the framework of technology-mediated learning (TML) [19]. The underlying premise of the constructivist model for learning is that knowledge is constructed as opposed to being transferred from the instructor to students. It believes that students learn better when they discover knowledge themselves at their own time and pace. Because of this, motivation and self-regulation are introduced to characterize the

online learning of the conceptual model. The VLE and TML are about the technological sides. The VLE is a system that delivers the teaching materials to students via the web. The system can also provide functions that assess students' performance and provide communication tools to encourage engagement among students and instructors.

Eom and Ashill [9] viewed online learning as an open system of three entities, and these are students, the instructor and the VLE. They are continuously interacting with one another and with their environments to optimize online learning outcomes and student satisfaction. TML incorporates different technologies in teaching and learning including computer-aided/assisted learning, computer-mediated communication, etc. TML describes "environments in which the learner's interactions with learning materials (e.g., readings, assignments, and exercises), peers, and/or instructors are mediated through advanced information technologies" [19]. The VLE and TML characterize the interactions among students, instructors, course design, instructor activities and assessment, which affect student satisfaction and perceived learning outcomes. The measure of the satisfaction degree of learning and learning achievement is important [20] and attitude change is an effective way to evaluate learning and satisfaction [21]. Therefore, we construct the conceptual framework of our research model as shown in Figure 1. The development of the hypotheses is discussed in the following sub-sections.

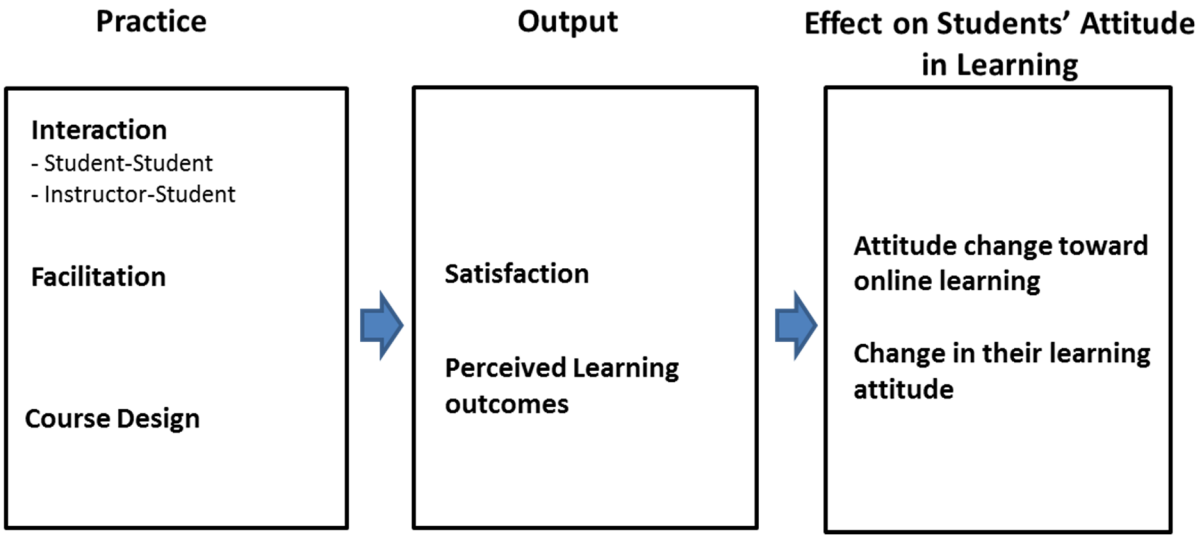

Figure 1. Conceptual Framework.

2.1. Interactions of Instructor-Student and Student-Student

Gurley [22] adopted the community of inquiry (CoI) framework [23] to study the necessary components of an ideal learning experience in blended and online learning courses and their impacts to the course quality including achievement of student learning outcomes and student satisfaction [24]. The CoI framework is a social constructivist model of learning processes in online and blended learning environments. It consists of three main components, including teaching presence, social presence and cognitive presence [22]. Research has shown that there is a relationship between the three presences and the students' satisfaction and perceived learning outcomes. Instructors must be intentionally present by selecting meaningful course resources, promoting student–student and student–faculty interactions, and guiding students through self-directed learning [25].

Interaction plays an important role in various forms of learning including face-to-face, blended (which have both face-to-face sessions and regular online discussion components) and fully online courses. Social constructivism views that learners gain knowledge by constructing understanding together and individuals make meanings through the interaction with each other and with the environment they live in [26]. Several theorists have

identified different ways of interaction in educational contexts such as interactions among students, interactions with the instructors and the content that is to be learned [27–30]. Among them, student-instructor and student-student interactions are the most common modes of interaction. Theories emphasizes on the impact of interactions in student learning. Interactions can help build a learning community that encourages critical thinking, problem solving, analysis, integration and synthesis; provides cognitive supports to learners; and ultimately promotes a deeper understanding of the material. Interaction can also help reduce transactional distance and strengthen students' psychological connection to the course by enhancing 'social presence'. Interaction promotes learning through active participation and enables cognitive engagement for developing higher-order knowledge [31]. Duncan-Howell [32] and Matzat [33] also point out the need of belonging as a desire for regular social contact with students to whom one feels connected. They suggested that instructors of online courses to establish and sustain students' sense of belongingness through the development of their interpersonal relationships and their sense of community.

Many pieces of research have been done to investigate the relationship between the interaction and both the perceived learning outcomes and satisfaction over the past decade. However, there are inconsistent, even conflicting, results for the relationship. Jaggars et al. [34] and Arbaugh and Benbunan-Fich [35] found that frequent and effective student-instructor interaction creates an environment that encourages students to commit themselves to course and perform at a stronger academic level. In their findings, the student-student interaction has no significant impact. However, the study of Arbaugh et al. [36] shows that all modes of interaction have positive and significant impact to student learning outcomes. Only student-student interaction is significant in predicting satisfaction. One possible reason of the inconsistent finding is the quality of the interaction. Some studies showed that little interaction was less helpful and made the students feel disconnected from their instructors and peers. More recently, theorists and researchers have begun to move beyond examining the extent of interaction to investigating its quality. Because of this, in this study, we focus on constructive interaction that has a clear purpose and delivery meaningful content to each party during COVID-19. We therefore hypothesize:

Hypothesis 1a (H1a). *Constructive online interactions between students and students is positively related to student satisfaction.*

Hypothesis 1b (H1b). *Constructive online interactions between students and students is positively related to perceived learning outcomes.*

Hypothesis 2a (H2a). *Constructive online interactions between instructor and students is positively related to student satisfaction.*

Hypothesis 2b (H2b). *Constructive online interactions between instructor and students is positively related to perceived learning outcomes.*

2.2. Facilitation

One of the major roles of an instructor is to implement and deliver the course content to students. However, unlike classroom settings, online learning has the potential to isolate learners, and the instructor needs to adopt different strategies to help students and mitigate the threat [37]. Several research works have shown that different online course facilitation strategies have different effects in helping with instructor in various aspects and learning across students [38]. Facilitation strategies such as the instructor's timely response to students' emails and discussion forums, timely grading and feedback of assignments, personal response to students' needs appeared to have more impact on key outcomes, but other strategies like synchronous learning sessions or an interactive syllabus were less influential [39]. Berge [40] proposed the Instructor's Roles Model, which shifted focus of an instructor from an expert of knowledge delivery to a course facilitator, and group facilitation into four different types: Pedagogical, Social, Managerial and Technical.

Researchers have examined specific aspects of facilitation. Hosler and Arend [41] found that discourse facilitation is key to elicit critical thinking or cognitive presence and noted that course organization and timely specific feedback improved students' participation.

Hung and Chou [42] developed an instrument, the online instructor role and behavior scale, and used it to examine the perceptions of students toward instructor roles in blended and online learning environment. In their studies, they identify five constructs and these are course designer and organizer, discussion facilitator, social supporter, technology facilitator and assessment designer. Students receiving immediate feedback perceived it to be more useful for learning than delayed feedback [43]. Besides this, Arbaugh [44] found that the two different roles of an online instructor, which are teaching presence and immediacy behaviors, have a positive significant relationship with the students' perceived learning outcomes and satisfactions in online MBA courses. The role being teaching presence includes facilitation and direct instruction of cognitive social presence to produce meaningful and educationally learning outcomes. The immediacy behaviors refer to verbal and nonverbal communicative actions that send positive messages of liking and closeness, decrease psychological distance between people and positively affect student state motivation such as calling students by their first name, using humor or providing prompt comments on assignments. We therefore hypothesize the following:

Hypothesis 3a (H3a). *Quality facilitation is positively related to student satisfaction.*

Hypothesis 3b (H3b). *Quality facilitation is positively related to learning outcome.*

2.3. Online Course Design

The cognitive information processing model stipulates that students learn better when the course design and teaching method match their learning style, implying that if the course could be designed to fit a wider range of students' learning style, they would be more satisfied since it is likely that they will gain a better outcome. Technology makes it more feasible to deliver a wider range of pedagogies with the ever more sophisticated systems like Blackboard and Canvas. Based on this school of thought, Martin et al. [45] chose online course design, online course assessment and evaluation, and online course facilitation as the key elements for effective online teaching. The selection of these elements is based on a literature review with different keyword search among a wide array of academic databases. Moreover, course design is one of the three fundamental elements that could impact the satisfaction and outcome of students in the e-learning environment [46]. Moore and Kearsley [47] also demonstrated that students, from the cognitive perspective, could create new knowledge through understanding and internalizing previous knowledge. Studies based on Keller [48] perspective of satisfaction, have shown that online classes provided the flexibility that the students need, and that online classes would be most satisfying when the course is designed to support student-centric learning [49].

Thus, course design and the written materials provided is an important factor in influencing students' perspectives on learning. We therefore hypothesize:

Hypothesis 4a (H4a). *Online course design is positively related to student satisfaction.*

Hypothesis 4b (H4b). *Online course design is positively related to learning outcome.*

2.4. Student Attitude in Online Learning Environment

Motivation is one of the fundamental building blocks in the study of student learning in the field of education. Learner motivation has been found to have association with course satisfaction [50] and achievement [51]. One of the important motivation theories which has been successfully applied in various settings and environments is the self-determination theory [15]. Moreover, it has been utilized as a mean to study various underlying factors of outcomes and activities in the learning process [52]. Using it as a framework, various

scholars [53,54] reported that heighten motivation leads to better outcomes and thus a more positive attitude toward learning.

Previous studies have applied motivation and self-determination theories to study students' negative form of learning behavior, such as academic dishonesty [55], and positive form of learning behavior, such as interest and enjoyment in learning [56]. As the online environment could implement a wider range of teaching pedagogies to support a wider range of students, facilitate interactions between all parties involved, as well as allowing better and more flexible facilitation by the instructors, we believe that all these lead to better motivation in students, thus improving learning outcome and satisfaction. This subsequently positively changes students' attitude toward online learning and heighten their learning attitude. Thus, we hypothesize in the online environment during the COVID-19 outbreak:

Hypothesis 5a (H5a). *Student satisfaction is positively related to a positive change in attitude toward online learning.*

Hypothesis 5b (H5b). *Student satisfaction is positively related to a positive change in their learning attitude.*

Hypothesis 6a (H6a). *Perceived learning outcome is positively related to a positive change in attitude toward online learning.*

Hypothesis 6b (H6b). *Perceived learning outcome is positively related to a positive change in their learning attitude.*

2.5. Perceived Learning Outcome and Student Satisfaction

In the field of higher education, both student satisfaction and perceived learning outcome have become two important matrices that warrant further investigation. Student satisfaction is often being used as a measure to improve students' experience, which has major practical implications for educational establishments. Various studies throughout the past decade have identify different factors which could impact student satisfaction in higher education including, but not limited to, the perception of learning outcomes (e.g., [10,57]). Although they focus mostly on in-person teaching environment, more recently Baber [58] found that learning outcome has a positive impact on student satisfaction in his cross-country study (including South Korea and India) of the mediating effect of perceived learning outcome in the online environment. We therefore hypothesize:

Hypothesis 7 (H7). *Perceived learning outcome is positively related to student satisfaction.*

3. Methods

3.1. Data Collection

A purposeful sample of 400 full-time undergraduate students from 11 universities in Hong Kong, including 8 public and 3 private universities, was recruited online. All of them attended fully face-to-face classes in the first semester (around September to December 2019) and fully online classes due to the COVID-19 pandemic in the second semester (around February to May 2020) of the academic year of 2019/20. We identified our target respondents through personal networks and referrals, and we then sent an e-mail invitation, an information sheet and a hyperlink to the online survey using Qualtrics. To ensure the quality of the online survey, it was pretested on 10 students from 3 universities before the main field survey. The pretest results showed that respondents were able to answer all the survey questions without difficulty, and only a few minor changes were made to the wording used in the survey after the pretest.

Some 62.5% of the surveyed students were female. Overall, we had a good balance between senior (year 3, 4 and above) and junior (year 1 and year 2) years, with 55.3% in their senior years and 44.7% being in their junior years. We also had a spread in the variety

of disciplines: the highest being Business students (27.0%), followed by social sciences (13.3%). In addition, we achieved a good balance between private and public universities, with 46.0% being in public universities and 54.0% in private universities in Hong Kong. Table 1 summarizes the demographics of the surveyed students.

Table 1. Demographics of the Surveyed Students.

	Frequency	Percentage (%)
Gender		
Male	150	37.5
Female	250	62.5
Academic Year		
Senior year	221	55.3
Junior year	179	44.7
Academic Program		
Business	108	27.0
Social Sciences	53	13.3
Arts	32	8.0
Science	54	13.5
Medicine/Health Care	87	21.7
Others	66	16.5
Type of University		
Public	184	46.0
Private	216	54.0

3.2. Instrument Design and Validation

The survey items with their means and standard deviations are provided in Appendix A. We developed the survey items based on or with reference to literature [9,59] and used 7-point Likert scales (1 = strongly disagree; 7 = strongly agree). Since there is a lack of suitable constructs on the change of attitude, we developed our own to be used in this study. To ensure the reliability and validity of all constructs used in this study, the initial items were reviewed by four academics, who were asked to assess whether the items described and measured what they were designed for. A confirmatory factor analysis using Partial Least Square (PLS) was conducted to test the measurement model. Results of this analysis were then employed to evaluate the reliability, convergent validity and discriminant validity of our measures. Table 2 displays the item loadings, composite reliabilities, Cronbach's alphas and average variance extracted of the constructs. It is found that the composite reliabilities and Cronbach's alphas were all above 0.7, the benchmark for acceptable reliability [60]. In addition, all of the factor loadings are at least 0.7, and the average variance extracted for each construct was larger than 0.5, thus demonstrating that the items satisfy the requirements for convergent validity [61].

We show the construct corrections and the square root of average variance extracted in Table 3. It was found that the square root of the average variance extracted for each construct exceeded its correlations with all of the other constructs [62], representing a satisfactory discriminant validity. The results demonstrate that all the constructs used in this study achieved satisfactory psychometric properties.

Table 2. Item Loadings, Composite Reliabilities and Cronbach's Alphas of the Constructs.

Construct and Items	Factor Loading	CR	Cronbach's α	AVE
Constructive student-student interaction (SSI)		0.910	0.868	0.717
SSI1	0.832			
SSI2	0.874			
SSI3	0.802			
SSI4	0.877			
Constructive instructor-student interaction (CIS)		0.910	0.869	0.720
CIS1	0.903			
CIS2	0.907			
CIS3	0.894			
CIS4	0.665			
Quality facilitation (QF)		0.922	0.894	0.702
QF1	0.853			
QF2	0.851			
QF3	0.822			
QF4	0.828			
QF5	0.835			
Online course design (OCD)		0.914	0.882	0.681
OCD1	0.833			
OCD2	0.883			
OCD3	0.842			
OCD4	0.802			
OCD5	0.760			
Perceived learning outcome (LO)		0.935	0.906	0.782
LO1	0.819			
LO2	0.902			
LO3	0.914			
LO4	0.900			
Satisfaction (SAT)		0.954	0.904	0.912
SAT1	0.959			
SAT2	0.950			
Attitude change toward online learning (AOL)		0.942	0.878	0.891
AOL1	0.950			
AOL2	0.938			
Change in learning attitude (CLA)		0.959	0.914	0.920
CLA1	0.957			
CLA2	0.962			

Note: CR: composite reliability; Cronbach's α: Cronbach's alpha; AVE: average variance extracted.

Table 3. Construct Correlations.

	CLA	AOL	CIS	SSI	LO	SAT	QF	OCD
CLA	0.959							
AOL	0.858	0.944						
CIS	0.508	0.424	0.848					
SSI	0.555	0.502	0.713	0.847				
LO	0.792	0.724	0.538	0.633	0.884			
SAT	0.744	0.704	0.594	0.611	0.782	0.955		
QF	0.426	0.353	0.617	0.531	0.480	0.618	0.838	
OCD	0.474	0.362	0.565	0.540	0.542	0.669	0.715	0.825

Diagonal elements represent the square root of AVE. CLA, change in learning attitude; AOL, attitude change toward online learning; CIS, constructive instructor-student interaction; SSI, constructive student-student interaction; LO, perceived learning outcome; SAT, satisfaction; QF, quality facilitation; OCD, online learning design.

4. Results

The PLS algorithm, followed by a bootstrapping re-sampling method (500 subsamples), was used to evaluate the research model [63]. We calculated the significance of each path using a two-tailed t test. The path coefficients are depicted in Figure 2 and the results

of hypothesis testing are shown in Table 4. PLS provides various measures of model fit. Amongst those measures, Standardized Root Mean Square Residual (SRMR) is deemed to be a reliable and appropriate model fit measure for a sample size of 400 with lower positive bias. A value of 0 represent a perfect fit and a model of less than 0.08 is considered a good fit [64], and the SRMR of our model is 0.066.

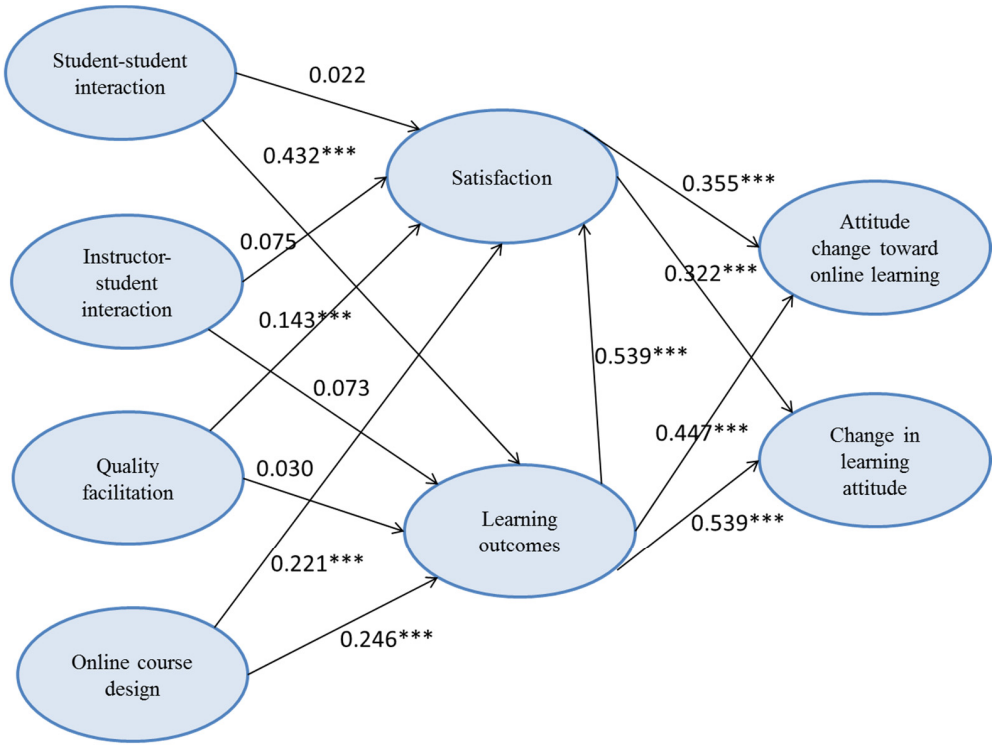

Figure 2. Model results with path coefficients.

Table 4. Results of the Hypothesis Testing.

Hypothesis	Supported?
H1a: Constructive student-student interaction $\xrightarrow{+}$ Student satisfaction	No
H1b: Constructive student-student interaction $\xrightarrow{+}$ Perceived learning outcomes	Yes
H2a: Constructive instructor-student interaction $\xrightarrow{+}$ Student satisfaction	No
H2b: Constructive instructor-student interaction $\xrightarrow{+}$ Perceived learning outcomes	No
H3a: Quality facilitation $\xrightarrow{+}$ Student satisfaction	Yes
H3b: Quality facilitation $\xrightarrow{+}$ Perceived learning outcomes	No
H4a: Online course design $\xrightarrow{+}$ Student satisfaction	Yes
H4b: Online course design $\xrightarrow{+}$ Perceived learning outcomes	Yes
H5a: Student satisfaction $\xrightarrow{+}$ Positive attitude change toward online learning	Yes
H5b: Student satisfaction $\xrightarrow{+}$ Positive change in learning attitude	Yes
H6a: Perceived learning outcome $\xrightarrow{+}$ Positive attitude change toward online learning	Yes
H6b: Perceived learning outcome $\xrightarrow{+}$ Positive change in learning attitude	Yes
H7: Perceived learning outcome $\xrightarrow{+}$ Student satisfaction	Yes

Nine (H1b, H3a, H4a, H4b, H5a, H5b, H6a, H6b and H7) out of our 13 hypotheses are significant at $p < 0.001$. H1a, H2a, H2b and H3b are not significant. H1a is the interactions between students, which were found not to have a significant impact on students' perceived change in satisfaction in the online environment. In our dialogues with students in a post-hoc focus group, one reason was that students were not, in general, able to effectively interact with other students during COVID-19, thus such interaction does not impact the change in their satisfaction toward online learning.

Surprisingly, H2a and H2b were also found to have an insignificant impact in our model. They are the impact of interactions between teaching staff and students on the perceived change in satisfaction and attitude toward online learning. Contrary to common belief and the school of scholars who have studies such interactions outlined in [29], interactions are proven to be beneficial at different levels of educations. However, the results here show that it has no impact on the perceived benefits of online learning. One direction we could explore is the cultural differences between the east and west. Traditionally in the east, the power distance between instructors and students is high, and the mode of learning is mainly lecture [65]. Online settings lessen the chance and desire for students to interact with their instructors, thus lessening their perceived importance of such interactions, hence also the benefits they could obtain from such interactions.

H3b, which is the impact of quality facilitation on perceived learning outcome, was found to be insignificant as well. The result is surprising at the first glance; however, taking into account of the insignificance of H2a and H2b, instructor personal involvement, whether it is with the students or in responding and facilitating in the online environment, seems to have little effect on perceived learning outcome. It may be because these instructors are not experienced in teaching online. As aforementioned, online facilitation requires different skill sets, one being technical competence in using all the different online tools, another being if enough tools were being provided by the respective establishments. During the sudden outbreak of COVID-19, the majority of the instructors had to switch to the online mode almost without training, and hardly anyone had any previous experience on using online teaching tools. It makes facilitation very difficult in the online setting when the facilitators themselves were struggling to familiarize themselves with the tools they are using. Moreover, it was also unclear if the establishments had provided enough of these tools and training for their instructors to facilitate learning online.

5. Discussion

For the nine hypotheses which are found to be significant, perceived learning outcome is by far the biggest contributing factor to both perceived changed in learning attitude and attitude toward online learning. Perceived learning outcome also contributes heavily to student satisfaction. Therefore, it is crucial that we know what effectively contributes to the improvement of perceived learning outcome in the online environment. From our model, interactions between students and course design are the major contributors to perceived learning outcome. This finding implies that if we would like to improve students' perception of online learning and their attitude toward it, we must first enhance the perceived learning outcome. There are two ways in achieving the said result: through better facilitation of online interactions between students, promoting peer learning; and through improving course design so that it can support different learning styles and encourage self-learning online [9]. It is proposed that educational establishments should provide tools such as online discussion, forum or group facilitation such as "breakout rooms" on Zoom so that students could conveniently "meet" each other virtually and be able to learn and help each other. Instructors, on the other hand, should encourage interaction between students by helping them with scheduling and putting all the tools into one place e.g., Blackboard, Canvas or Moodle for easy access. They can also encourage students to form Facebook or WhatsApp groups for better communication among each other.

Course design is also one of the significant contributors to perceived learning outcome and it also partially but significantly impacts perceived satisfaction. Therefore, instructors

who wish to teach online should spend more time in improving their course design so that their course materials can be effectively delivered to their students in different ways to support different learning style, such as via PowerPoint slides, videos, quizzes and online games [66]. These tools are available through most commonly use learning platforms and other websites. Additionally, their teaching philosophy and aim must be clearly communicated in writing and deadlines clearly layout at the beginning of the term, so that students understand what is required of them and where everything is being placed. Most learning platforms are equipped with calendar function and announcements can be employed periodically to remind students of deadlines and course requirements.

Quality facilitation though does not impact perceived learning outcome, but it has a small but significant effect on perceived satisfaction. By effectively laying out their instructions, providing different kinds of teaching materials and being responsive when problems arise, in general, it could help increase student satisfaction in the online environment [67]. The grading scheme should also be change by tying it to the online activities and assignments to further facilitate students' learning by ensuring that all materials presented would be studied the way they were designed for.

On the other hand, there are also lessons to learn from the insignificant findings of this study. Unlike the findings in some previous studies (e.g., [9]), we found interactions between instructors and students to be less effective in the online environment. Therefore, instead of actively finding a way to interact with every student online, time would be better utilized in responding to problems when they arise and in improving the delivery of the course materials, as well as facilitating peer learning. Software platforms provide plenty of ways for instructors to cater to students' learning en masse, particularly for large classes with more than 100 students. Customizing learning tools is a more cost- and time-effective way to deliver a better learning experience to each and every student in class online.

Another learning from this study is that instructors need to be familiar with online systems and tools to be effective facilitators. Educational establishments should be actively training their teaching staff on different systems and tools, to prepare for future online learning opportunities, and/or incorporate quality technical tools purchased during COVID-19 to further improve the learning environment for students in the future [68]. This can improve the sustainability of both the system purchased as well the adopted institutions by enhancing the learning environment for students. Technologies allow instructors to be more effective in implementing different pedagogies such as flipped or blended learning by providing better feedback and monitoring channels [69].

Other than the delivery side of teaching and learning, more focus should be given on how to prepare students in online environment, since we believe their technology competency also plays an important part of facilitating peer learning and their ability to work with different style of materials presented online [70]. Moreover, now is the best opportunity to study ways to incorporate information technology and digital tools in enhancing classroom experience for the future, since an array of tools have already been purchased for the cause of teaching during COVID-19 outbreak. For the sustainable development, effective blended learning and flipped classroom pedagogies may be important and interesting fields to explore in the future [71,72].

Like most empirical studies, this study has limitations that warrant further considerations. One limitation is the dependence on the self-reported data. We tried to enhance the quality of the responses through ex ante approaches in the survey design stage, including anonymous responses, identifying the target respondents via personal networks and referrals, providing information sheet to respondents, and using diverse samples. In addition, we included a "check item" asking a simple question with an exact answer: "What is the sum of 1 plus 2?" in the middle of a survey [63]. If a respondent could not answer the check question correctly, we did not count this response as a valid one. Another limitation is the lack of instruments to measure students' change of attitude in learning and toward online learning due to COVID-19 pandemic. Therefore, we followed a rigorous instrument development process to develop instruments to measure the attitude change

toward online learning and change in learning attitude. We made every effort to ensure reliability and validity of all the constructs. We conducted the content analysis and invited four academics to review all items used in the survey [73]. Then, we reconfirmed that the constructs achieved satisfactory psychometric properties by analyzing their item loadings, composite reliabilities, Cronbach's alphas, average variance extracted, and correlations with other constructs [74]. The third limitation is that all data were collected in Hong Kong. More research is needed in examining the culture differences and generalization of the results.

6. Conclusions

The COVID-19 pandemic has brought upon unprecedented challenges [75,76]. While the long-term outlook of the COVID-19 pandemic is still highly uncertain, educational continuity is essential. This study explores the change of learning attitude and attitude toward online learning in a timely manner, just after students experienced both learning environments during COVID-19 pandemic in Hong Kong when all face-to-face learning ceased, and instead all were forced online in a very short period of time. It is difficult to predict every virus or disaster in the future. However, it is costly to suspend all of the education since it inhibits the sustainable development of the society. Therefore, it is necessary to confirm if the online teaching mode can replace classroom teaching mode in those extreme situations.

The most significant findings in this study are that interactions between students and course design contribute the most to students' change of attitudes. On the contrary, interactions between instructor and students were found to play no part in the online settings. We have also provided recommendations on improving students' attitude based on the survey findings.

This study provides insights for researchers and instructors on developing suitable teaching and learning strategy, especially during the days requiring social distancing and enhanced hygiene measures. However, there are still many questions to answer regarding the factors for sustainable online learning in higher education, such as the technical competency of both instructors and students, the completeness of the information technology infrastructure provided to create the online environment, as well as the cultural differences between the east and the west. We expect more research to be conducted in these areas.

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Appendix A

Table A1. Survey Items with Means and Standard Deviations.

Construct and Items (1 = Strongly Disagree; 7 = Strongly Agree)	Mean	Standard Deviation
Constructive student-student interaction (SSI)		
SSI1: In general, I had constructive interactions with other students frequently in the online classes due to COVID-19.	3.16	1.480
SSI2: In the online classes during COVID-19, the level of constructive interactions between students was generally high.	3.12	1.388
SSI3: In the online classes during COVID-19, I, generally, learned more from my fellow students than in face-to-face classes at the university.	2.86	1.514
SSI4: The constructive interactions between students in the online classes due to COVID-19 helped me improve the quality of the learning outcomes in general.	3.16	1.416
Constructive instructor-student interaction (CIS)		
CIS1: In general, I had constructive interactions with the instructors frequently in this online classes due to COVID-19.	3.61	1.469
CIS2: In general, the level of constructive interactions between the instructors and students was high in the online classes due to COVID-19.	3.44	1.499
CIS3: The constructive interactions between the instructors and students in the online classes helped me improve the quality of learning outcomes in general.	3.51	1.527
CIS4: The constructive interactions between students and the instructors was an important learning component in the online classes due to COVID-19.	4.39	1.706
Quality facilitation (QF)		
QF1: In general, the instructors were actively involved in facilitating the online classes due to COVID-19.	4.49	1.315
QF2: In general, the instructors in the online classes provided timely and helpful feedback on assignments, exams, or projects.	4.30	1.443
QF3: In general, the instructors in the online classes stimulated students to exert intellectual effort beyond that required by face-to-face classes.	3.87	1.336
QF4: In general, the instructors cared about my individual learning in the online classes.	3.72	1.419
QF5: In general, the instructors in the online classes were responsive to student concerns.	4.44	1.409
Online course design (OCD)		
OCD1: The course objectives and procedures of the online classes were generally clearly communicated.	4.20	1.319
OCD2: The design of the modules of the online classes was generally well organized into logical and understandable components.	4.22	1.278
OCD3: The course materials of the online classes were generally interesting and stimulated my desire to learn.	3.75	1.368
OCD4: In general, the course materials of the online classes due to COVID-19 supplied me with an effective range of challenges.	3.99	1.338
OCD5: Student grading components such as assignments, projects, and exams were related to learning objectives of the online classes due to COVID-19 in general.	4.29	1.330
Perceived learning outcome (LO)		
LO1: The academic quality of the online classes due to COVID-19 is on par with face-to-face classes I have taken.	3.51	1.566
LO2: I have learned as much from the online classes due to COVID-19 as I might have from a face-to-face version of the courses.	3.51	1.638
LO3: I learn more in online classes due to COVID-19 than in face-to-face classes.	3.19	1.692
LO4: The quality of the learning experience in online classes due to COVID-19 is better than in face-to-face classes.	3.21	1.724
Satisfaction (SAT)		
SAT1: As a whole, I was very satisfied with the online classes due to COVID-19.	3.69	1.596
SAT2: As a whole, the online classes due to COVID-19 were successful.	3.83	1.535

Table A1. *Cont.*

Construct and Items (1 = Strongly Disagree; 7 = Strongly Agree)	Mean	Standard Deviation
Atitude change toward online learning (AOL)		
AOL1: I prefer online classes to face to face classes.	3.32	1.900
AOL2: Online classes could replace face to face classes.	2.87	1.764
Change in learning attitude (CLA)		
CLA1: My interest in learning has been increased.	3.16	1.725
CLA2: I can learn more from the online classes than from the face to face classes.	3.15	1.654

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