COVID-19 and Contactless Learning and Teaching: The Impact of Active Participation and User Acceptance

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Abstract

Tertiary education in Hong Kong has dramatically changed after the outbreak of COVID-19. Teaching pedagogy and delivery method have been transformed into "Contactless Learning and Teaching" and online learning. However, the focus has been on online learning while seldom analyzing the effect of "Contactless Learning and Teaching" among previous research. This research addressed this gap by studying 156 university students in Hong Kong. ATLAS, a mobile app integrated with iBeacon technology was developed to deliver learning materials in "Contactless Learning and Teaching". The findings indicated that students who spent more time on "Contactless Learning and Teaching" have better academic performance. The active participation in "Contactless Learning and Teaching" and better academic results could also be explained by the Technology Acceptance Model in this study. The current study proves that iBeacon displays the potential of delivering learning and teaching materials amid the pandemic using the "Contactless Learning and Teaching" approach.

KEYWORDS

iBeacon/BLE technology, COVID-19, academic performance, contactless learning and teaching, technology acceptance model

Introduction

Since the sudden outbreak of COVID-19 in China around 2020 during the Spring Festival, it has spread rapidly worldwide (Huang et al., 2020). The disease spread relatively fast and affected the whole world (Singhal, 2020). After the pandemic outbreak, the Chinese government restricted all recreational activities, visits, and gatherings during the Spring Festival to prevent the spread of the virus (Tian et al., 2020). The COVID-19 now becomes a global issue (Sohrabi et al., 2020).

Several measures have been taken to prevent physical contact during the pandemic and contain the spread of COVID-19. The most stringent measure for epidemic prevention is lockdown (Lonergan & Chalmers, 2020), which aims to restrict the movement/mobility.of people. Although the restriction measures are varied from country to country (Flaxman et al., 2020), the ultimate goal is to reduce economic activity and social interaction. For example, the French government implemented a strict nationwide blockade (Di Domenico et al., 2020); whereas, in some other countries, less strict measures of the lockdown are taken, such as discouraging social and physical distancing, prohibiting large-scale gatherings, and restricting the travel of residents (Born et al., 2021; Yamamoto et al., 2020). Psychological studies have found that the lockdown during the pandemic would influence individuals' well-being and psychosocial functioning, which would lead to a number of symptoms, such as depression, anxiety, sleep disturbances (Ernstsen & Havnen, 2021). Goolsbee and Syverson (2021) have also reported the economic collapse in 2020 caused by the pandemic of COVID-19. Thus, the revenues of the government have been reduced while they need to spend more to support those people in need (Bonaccorsi et al., 2020).

Influence of COVID-19 on higher education

COVID-19 has been spreading wantonly, exerting a great influence on people's life, work, and study. Like other social organizations, colleges and universities are also facing unprecedented challenges. The pandemic has forced the closure of schools, and more and more universities have to turn to online learning (Pokhrel & Chhetri, 2021). From the beginning of the outbreak to 3 April 2020, more than 90% of the students worldwide in more than 188 countries have been affected by COVID-19 (UNICEF, 2020). Online learning has been adopted as a learning method before the pandemic. Hrastinski (2008) argued that there are two types of online learning: asynchronous and synchronous types. Asynchronous learning is defined as allowing students to learn flexibly at their own pace, whereas synchronous learning is featured by using video-conferencing software to learn in real-time. Before the pandemic, most of the online learning methods were of the asynchronous type. Asynchronous learning is typical in MOOCs and it is similar to remote learning. Some of the components of asynchronous learning are integrated with the learning management system (LMS) in universities to enhance the learning experience of students as a supplementary means of face-to-face teaching. DeNeui and Dodge (2006) whether it would be beneficial to students to allow students to access the learning materials using LMS at any time. They found that the use of LMS is positively associated with students' academic performance. Thus, Daniel (2020) suggested that asynchronous learning is ideal as a learning method for universities and colleges under the pandemic since it is the simplest approach of remote teaching. Lowenthal et al. (2020) also examined asynchronous learning adopted in four universities in the U.S. They found that teachers will maintain their teaching quality under the pandemic even though they are not fully prepared or unprepared for remote teaching. However, asynchronous learning is not enough for students to achieve satisfying learning outcome under the pandemic if the interaction between teachers and students are needed as an essential condition for the discipline. For instance, the Harvard School of Dental Medicine was interviewed to collect feedback on remote teaching (Chen et al., 2020), and it is found that interactive elements are insufficient if asynchronous learning is adopted.

As a result, synchronous learning is preferred in some universities and colleges (Hrastinski, 2008). Students can discuss with their peers and ask teachers questions during the synchronous session. Technology has been developing rapidly and videoconferencing is frequently adopted and familiar to many people. Before the outbreak of COVID-19, scholars have already examined synchronous learning to satisfy the student's special needs. To name but a few, seven courses in Australian and New Zealand universities to implement synchronous learning for students who have to study remotely (Bower et al., 2015), and it is found that over 75% of students believe that they can gain same learning experience through synchronous learning as face-to-face learning. The results suggested that synchronous learning displays the potential of overcoming course delivery difficulties during the pandemic of COVID-19. For example, Guo (2020) also found that physics students have a better performance in basic calculus class as attending the synchronous online sessions than for those students absent in synchronous online sessions and only rely on asynchronous learning materials. For those students attending synchronous online sessions, more students believe that synchronous online sessions, which provide the opportunity for students to interact with the teacher, are the same as face-to-face teaching compared to their counterparts, implying that the engagement during lectures will be an important factor to facilitate students' study.

Despite the network support, great inconvenience is caused in delivering courses due to the pandemic of COVID-19; for this reason, it is necessary to carefully study the teaching quality and teaching pedagogy (Pokhrel & Chhetri, 2021). Moreover, such a serious epidemic has also caused a great psychological impact on students. College students are a vulnerable population, as they suffer more serious anxiety, depressive symptoms, and lack of self-esteem than the general public (Holm-Hadulla & Koutsoukou-Argyraki, 2015). What is more, a review by Aristovnik et al. (2020) indicates that negative emotions, including boredom, anxiety, and frustration are disturbing most teachers and students since they turned to another learning and teaching environment, and the students feel great burdens on students (Hernandez-Mella et al., 2019). Concerning the home quarantine during the epidemic, Aristovnik et al. (2020) also found that 42.6% of the students worried about their career future, and 40.2% about their study.

Besides, not every university or college, or every student in the world could benefit from synchronous online sessions. For example, most students from under-developed countries could not benefit from it due to technical issues (Coman et al., 2020), and there are not enough resources in some countries to implement synchronous teaching (Aboagye et al., 2021). Therefore, Suppan et al. (2021) re-designed asynchronous learning to include the element of engagement. They divided some medical students into groups with and without engagement modules in asynchronous teaching, and they found that students of asynchronous learning groups with engagement modules achieved better learning performance than their counterparts, implying that active participation during the class would be conducive to learning outcome, no matter it is synchronous or asynchronous teaching.

Contactless learning and teaching

To respond to the measures of the pandemic, the concept of "Contactless" is gradually become popular in many industries, such as healthcare service (Lee & Lee, 2021), sales and retails (Puriwat & Tripopsakul, 2021), hospitality (Kim et al., 2021), and human resources development (Yawson, 2020). Before the outbreak of COVID-19, the technology has been developing rapidly, so the contactless service could be provided in these industries, but there are few inventive provided to the practitioner to carry out the reform. The outbreak of COVID-19 became a trigger for an acceleration of the reform of contactless service (Makamure & Tsakeni, 2020). Hence, some scholars suggested that educators should develop contactless learning and teaching (Laplante, 2020). Online learning and teaching (including asynchronous and synchronous) are the formats in contactless learning and teaching. However, it is not enough for those disciplines requiring hands-on practice. In other words, the training of surgeons has been affected by the pandemic of COVID-19 since surgical trainees only had limited opportunities and clinical and surgical exposure to learning the operative and clinical skills (ElHawary et al., 2020), and it is necessary to urge the educators to provide a safe learning environment for those students. As a starting point, it is suggested that pencil-and-paper method should be replaced with advanced technology to monitor student attendance. For example, Ananta et al. (2020) used the smart card to monitor student's attendance records. In another example, Rajamanogaran et al. (2021) monitored student attendance in real-time using artificial intelligence. Teachers and students can be better prevented from the COVID-19 by using this contactless system. However, the above examples are given to discuss the logistic and administrative issues. It is also suggested that an innovative way should be adopted to implement the teaching for those disciplines that need hands-on experience.

One of the potential innovative ways that can be adopted for the teaching of those disciplines is self-learning location-based learning and teaching. Location-based learning and teaching have been applied to informal education settings for an extended period (Wang et al., 2017). For instance, Chen et al. (2017) developed a mobile app using iBeacon technology to facilitate students' self-learning in the science museum. They divided students into the self-learning and guidance group and found that the self-learning group would interact more with the exhibitions and gain a deeper understanding than their counterparts. Another example of informal education is a project led by Nosrati et al. (2018), who also adopted the iBeacon technology to disseminate Hamilton's cultural heritage and culture in Canada to the public. The results showed that the use of iBeacon app appreciation for culture and history had been boosted among Hamilton.

Other scholars had also used similar technology in formal education. For example, Schneider and Schaal (2017) developed a GPS-guided game (similar to Pokémon Go) for environmental education (EE) majors. Students are required to apply the knowledge of EE to address the location-specific issue in the real world. The results showed that with the use of GPS-guided game, the students' knowledge of EE and their awareness of environmental protection are greatly enhanced. Georgiou and Kyza (2018) also used a similar method for EE students, but they added the AR on top of the GPS-guided game. They identified a significant improvement in EE conceptual understanding, which is closely associated with the increased participation of students in the GPS-guided game. iBeacon technology has also been used in architectural design (Wu et al., 2016). The authors set up different Points of Interest (PoI) throughout the campus to drive students to learn smart green buildings. The results showed that it could help to improve the students' learning results regardless of their prior knowledge levels.

Other authors had also provided location-based services in the indoor environment. Atherton (2019) created several self-learning zones in different classrooms, so that students could learn simultaneously. They realized that students could learn collectively and independently, and the academic performance and motivation were improved among the independent learners. All the above studies have demonstrated that active participation in self-learning activities could help improve students' academic performance. Other studies have also shown that the teaching outcome of several disciplines benefits from it, such as language (Sun & Chang, 2014), cultural study (Hwang et al., 2017), history (Kyza & Georgiou, 2018), nutrition (Oppermann et al., 2018), and healthcare (Garrett et al., 2018). Therefore, the self-learning location-based learning and teaching found to positively influence the students' learning outcome of several disciplines since it provides the students with active learning opportunities. In contrast, it provides limited opportunity to the student in helping them achieve active learning outcomes by adopting synchronous or asynchronous teaching.

Factor to influence the implementation

The literature has shown a growing interest in using iBeacon or location-based technology in mobile to provide contactless learning and teaching (Ozdemir et al., 2018). However, only a few studies focus on how to encourage students to use the mobile app.

The application of location-based technology become famous in contactless learning and teaching recently. Many researchs are trying to investigate its features that influence learners and educators' degree of acceptance among those technology (Al-Emran et al., 2018). Empirical evidence indicates that those technologies can provide support to the students in their learning activities of many disciplines, including education (Liu et al., 2010), business (Mac Callum & Jeffrey, 2013), and information technology (Hamidi & Chavoshi, 2018). With enhanced affordances of contactless learning and teaching system, there would be growing interest in the factors that affect its acceptance (Althunibat, 2015).

Davis (1989) suggested the Technology Acceptance Model (TAM) to examine the determinants of users' acceptance for using the technology. Originally, TAM postulates that *perceived usefulness* and *perceived ease of use* are two main factors associated with the user acceptance. Perceived usefulness is defined as the degree to which the user believes that it would enhance their performance by using a specific system. Perceived ease of use refers to the degree to which the user believes that it would cost less effort by using a specific system. TAM also posits that the actual use of a specific system is determined by *behavioral intention to use*, determined by both perceived usefulness and *attitude toward using technology*. Figure 1 shows the proposed initial model of TAM.

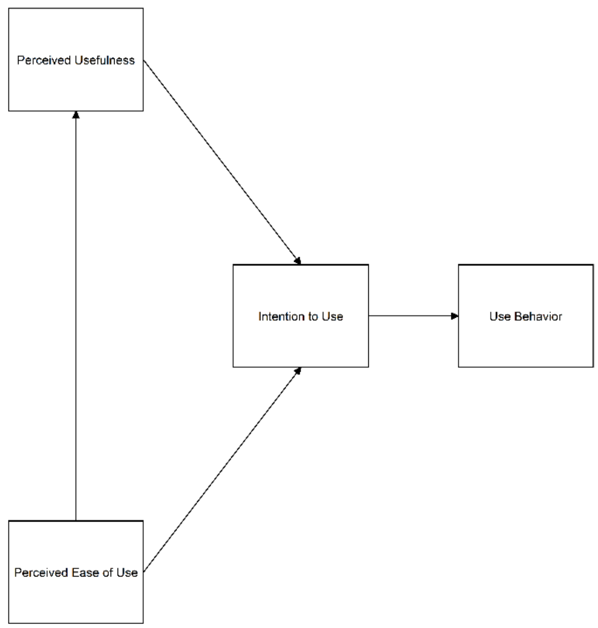

Figure 1. Original Technology Acceptance Model

After the publication of Davis (1989), in several studies, it is argued that the attitude toward the use of technology would be removed to simplify the model without losing the explaining power (Davis et al., 1989; Szajna, 1996). Therefore, the extended model, TAM2 (Venkatesh & Davis, 2000), and another subsequent model, UTUAT (Venkatesh et al., 2003) had removed the attitude toward using technology.

Šumak et al. (2011) conducted a meta-analysis to summarize the TAM-related studies, and they found that the perceived usefulness and the perceived ease of use are two major factors that affect user's intention with using e-learning systems. For instance, Brunel University offered a series of online courses in LMS and examined the factors of increasing the use of the platform (Abu-Al-Aish & Love, 2013), finding that both the perceived ease of use and the perceived usefulness have been significantly and positively associated to use of the platform. Another example of this relationship can be found in Asia (Wang et al., 2009). Since the outbreak of COVID-19, there is a growing trend of examining the use of online and remote learning using TAM. For example, Siron et al. (2020) used TAM to evaluate the use of e-learning platforms. They found that both the perceived usefulness and the perceived ease of use are the major factors affecting students' intention to use e-learning at several state universities in Indonesia during the pandemic.

Gaps in the literature and present study

The evidence suggests that active participation and great student engagement in self-learn location-based learning and teaching activity, are associated with better performance. Nevertheless, it is possible that some other factors such as user acceptance and academic discipline would affect the above relationship. There are some issues to notice due to the correlational nature of this study (Hung et al., 2017), as this study attempted to provide a better understanding of the influence of active participation based on user acceptance and academic discipline, which would provide insights into the issue and facilitate the educators to develop more effective teaching methods to help the students achieve better learning outcome during the pandemic (Devlin & Samarawickrema, 2010).

There are several gaps in the literature on the relationship between active participation and academic performance. First and foremost, the previous findings are concentrated on online and remote learning and teaching but paid less attention to the potential benefits of location-based learning and teaching. Focus is put on the TAM model instead of the relationship between TAM, academic discipline, and academic performance in most previous studies.

The present study tried to address these gaps by performing path analysis to include the TAM and academic discipline in our model (Sharma et al., 1981). In the present study, it hypothesizes that 1) perceived usefulness mediates the relationship between perceived ease of use and intention to use, 2) intention to use positively correlated with actual usage, 3) actual usage is positively correlated with academic performance, and 4) academic discipline does not moderate the relationship between actual usage and academic performance.

Method and procedure

Participants

We recruited study participants from The Hong Kong Polytechnic University, The University of Hong Kong, The Chinese University of Hong Kong, and Hong Kong Baptist University between January 2019 and December 2019. A total of 156 students from 7 courses in 4 disciplines participated in this study.

Location-based service: our use of ATLAS software and iBeacon hardware

The project team developed a learning and teaching system named as "Augmented Teaching and Learning Advancement System" (ATLAS). The mobile app for ATLAS was developed to deliver self-learn learning and teaching activities by utilizing iBeacon-based technology and realizing "Contactless Learning and Teaching". For every activity, the teacher would set up several learning locations to deliver learning and teaching material. After the teacher set up the contactless learning and teaching activity in ATLAS, the mobile app would guide the students to different locations. It depends on the students whether to participate in the contactless activity, and it is a voluntary activity without affecting their final academic performance. In addition to the functions mentioned above, students also used the ATLAS app to take quizzes and tests. Students' mobiles install the app on their mobile phones and sign the written consent before participating in the study. More details are provided on the ATLAS website: https://www.atlas-learn.com/.

Measurement

Academic performance

Academic performance was defined as students' in-class test scores in this study. Students were required to install the ATLAS app on their mobiles. All the tests were fact-based and designed based on multiple-choice questions. The quiz is organized via the ATLAS app and the participants' test scores are recorded in the form of a percentage.

Actual usage

We used the time of participation in self-learn location-based learning and teaching activity is taken as the actual index of use in this study. The ATLAS app recorded their participation time in seconds automatically when they participated in the activity. Since the participation is voluntary as a supplementary means of the lecture giving, the actual use was also operationalized and defined as active participation.

TAM

The perceived usefulness, perceived ease of use, and intention to use were adopted by introducing the Technology Acceptance Model (TAM). Three constructs were modified to fit our system (ATLAS), which contained 9, 4, and 3 items respectively for perceived usefulness, perceived ease of use, and intention to use. The items were rated using a five-point Likert scale (1 = strongly disagree and 5 = strongly agree), where Cronbach's alphas were 0.97, 0.88, and 0.94 respectively for perceived usefulness, perceived ease of use, and intention to use.

Academic discipline

We used Biglan (1973) classification is perform to divide the academic disciplines into soft (code = 1) or hard fields (code = 2). The disciplines are classified into soft (a low degree of consensus) and hard (a high degree of consensus) through the categorization.

Data Analysis

We performed a path analysis in R studio with the "lavaan" package, version 0.6-8 (Rosseel, 2012). Figure 2 displayed the hypothetical model being tested in the current study. We specified perceived usefulness as a mediator. The insignificant paths in the initial model will be removed, and then re-analyzed again until all the paths were significant. Maximum likelihood (ML) was used to estimate the parameter and the robust test statistic was reported. We specified 5000 bootstrap samples based on 95% confidence intervals (CIs). An indirect effect can be found when the 95% CIs do not include zero. Model fit would be indicated by a non-significant chi-square, Root Mean Square Error of Approximation (RMSEA) <0.06, Standardized Root Mean Square Residual (SRMA) <0.08 (Hu & Bentler, 1999). All alpha was set at 0.05, two-tailed.

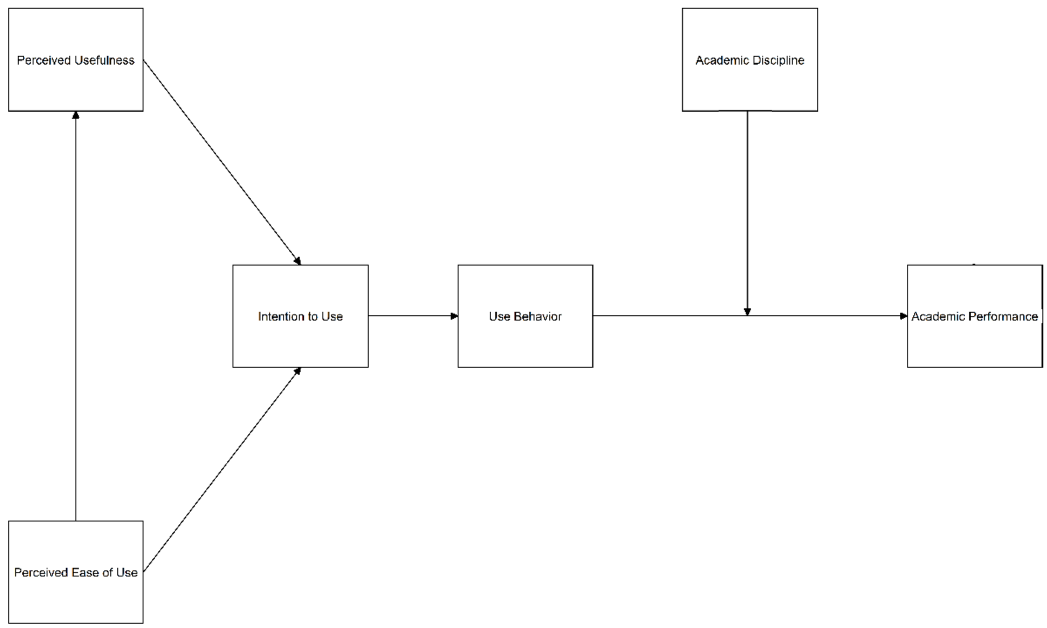

Figure 2. Hypothetical model

Results

As shown in Table 1, participants' average test score was 58.5%, and 92.3% of them were hard field. Most of them came from the Hong Kong Polytechnic University. Students participated in the self-learn learning and teaching activity for an average of 45.78 seconds (SD = 145.18). The mean scores of the perceived usefulness, perceived ease of use, and intention to use were 3.00 ± 0.92, 3.34 ± 0.86, and 3.04 ± 1.00, respectively.

Table 1. Descriptive information

	Mean / N	SD / %

Test score [%]	58.48	36.29
TAM		
Perceived usefulness	3.00	0.92
Perceived ease of use	3.34	0.86
Intention to use	3.04	1.00
Use Behavior [second]	45.78	145.18
Academic discipline		
Soft field	12	7.69%
Hard field	144	92.31%
University		
The Chinese University of Hong Kong	5	3.21%
Hong Kong Baptist University	7	4.49%
The Hong Kong Polytechnic University	129	82.69%
The University of Hong Kong	15	9.61%

Table 2 showed the results of our path analysis. The model fit index suggests that the initial model does not yield a goodness of fit (X^2 (11) = 391.694, p = <.001, RMSEA = .471 (90% CI = .432 - .512, SRMR = .197)). We removed the insignificant paths, which ranges from academic discipline to academic performance, and to interaction between use behavior and academic discipline, and re-analyzed the path analysis. The results showed that the final model yielded a goodness of fit (X^2 (5) = 5.669, p = .340, RMSEA = .029 (90% CI = .000 - .118, SRMR = .038)). The bootstrap result showed that perceived usefulness is a mediator of perceived ease of use (ß = .525, 95 % CI [.420, .626]). Table 3 shows indirect effect and general effect of perceived ease of use. Regarding the relationship between intention to use and actual usage, a positive relationship was identified (ß = 0.161, p = .042). Actual usage was also positively associated with academic performance (ß = 0.226, p = .004).

Table 2. Initial model

Path			Standardized coefficient	*p*
Perceived Ease of Use	→	Perceived Usefulness	0.760	<.001
Perceived Ease of Use	→	Intention to Use	0.127	.029
Perceived Usefulness	→	Intention to Use	0.806	<.001
Intention to Use	→	Use Behavior	0.161	.042
Use Behavior	→	Academic Performance	0.229	.003
Academic Discipline	→	Academic Performance	0.037	.900
Use Behavior X Academic Discipline	→	Academic Performance	0.000	.998

X^2 (11) = 391.694, p = <.001, RMSEA = .471 (90% CI = .432 - .512, SRMR = .197)

Table 3. Final model

Path			Standardized coefficient	*p*
Perceived Ease of Use	→	Perceived Usefulness	0.650	<.001
Perceived Ease of Use	→	Intention to Use	0.109	.029
Perceived Usefulness	→	Intention to Use	0.806	<.001
Intention to Use	→	Use Behavior	0.161	.042
Use Behavior	→	Academic Performance	0.226	.004

X^2 (5) = 5.669, p = .340, RMSEA = .029 (90% CI = .000 - .118, SRMR = .038)

Table 4. Indirect effect to Intention to Use

	Indirect effect via Perceived Usefulness	Total effect
	Standardized coefficient	Standardized coefficient
Perceived Ease of Use	0.525 [0.420, 0.626]	0.633 [0.511, 0.740]

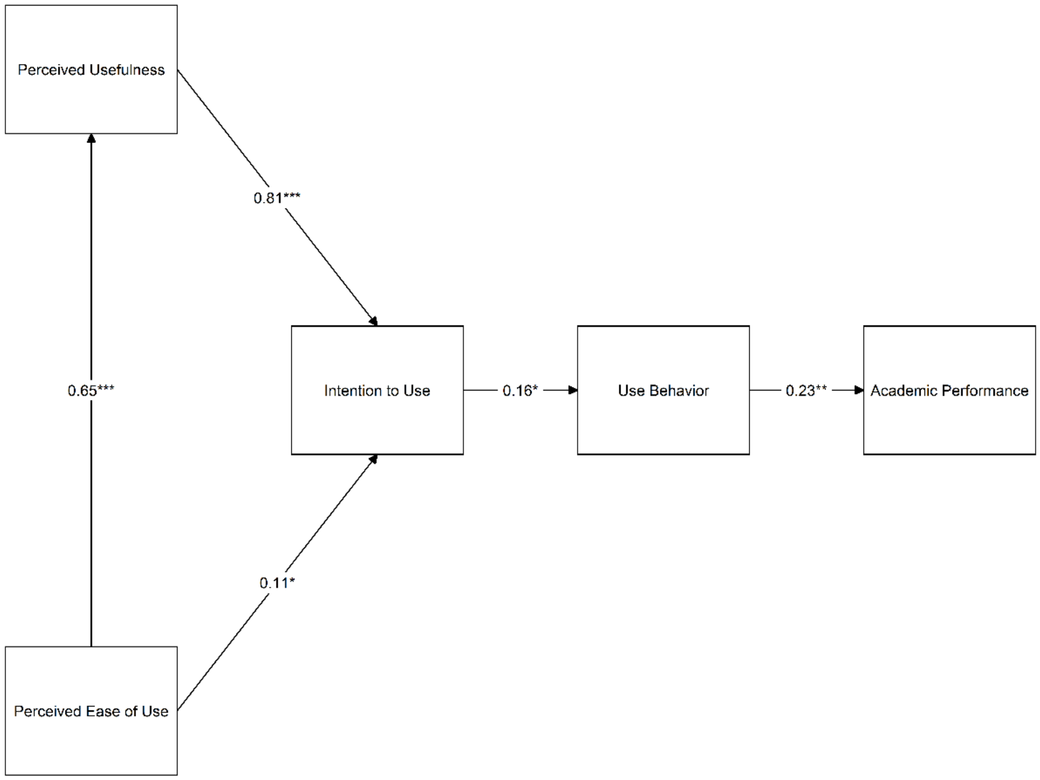

Figure 3. Final model

Discussion

The findings suggested a significant relationship between college students' active participation and their academic performance. Moreover, this finding was consistent with the recent research (Carini et al., 2006; Kahu & Nelson, 2017). For instance, Carini et al. (2006) found that enhanced engagement of students is associated with improved learning outcomes. Their study also showed that students with lower learning ability could benefit more from improved engagement than their more capable counterparts. Another example of it is the research by Kahu and Nelson (2017), who assessed the emotional and cognitive engagement of students realized that students are emotionally engaged when they are interested in the teaching content and cognitively engaged when they believe in their ability to understand and complete a learning task. They argued that emotional and cognitive engagement could serve as important predictive factors of academic success. Therefore, we might explain this finding by arguing that students who actively participated in the activity might be more engaged than their counterparts (Montello, 1988) to improve their academic performance.

The moderation analysis also revealed that academic discipline does not moderate the relationship between college students' active participation and academic performance. This indicates that active participation is conducive to various disciplines in terms of academic performance. This finding is consistent with that of Ifinedo et al. (2018)'s. They conducted a cross-sectional survey to examine the use of Moodle and found that there was no significant interaction effect between academic discipline and use of Moodle in terms of academic performance.

Also, this study's findings suggested that the perceived usefulness of the mobile app did indeed mediate the relationship between perceived ease of use and intention to use. Furthermore, the findings showed that students who had the intention to use the mobile app would actively participate in the self-learning location-based learning and teaching activity. This finding was consistent with previous research (Dasgupta et al., 2002), which indicated that TAM would be useful in explaining the use of the e-learning system. The results also implied that perceived usefulness and perceived ease of use might affect academic performance ultimately, in the sense that technology acceptance, active learning, and appropriate learning technology might be more common in students with high expectations of the specific e-learning system. Previous studies had also supported that TAM is a predictive instrument for student's academic performance using different e-learning system, for example, Moodle (Ifinedo et al., 2018), Cloud Computing (Ali et al., 2018), UCOM (Tawafak et al., 2018), and Prometheus, which was developed by the George Washington University (Dasgupta et al., 2002). Hence, the current study differed from previous studies, in which using the e-learning system is compulsory. The use of ATLAS in the current study is voluntary. Our results had added to the literature that TAM would be explained active participation in a voluntary-based e-learning system.

Other studies have shown that active learning beyond the classroom could also potentially benefit academic performance. According to Rose et al. (2019), the final exam results are greatly improved if the student watches the supplementary learning video after class. Kudish et al. (2016) also argued that students who engage in the voluntary-based workshop improve academic performance as measured by GPA. The benefit of active learning beyond the classroom is also documented by Little (2015). They conducted a literature review on the flipped classroom, which used pre-recorded lecture videos to deliver learning and teaching materials outside the classroom, and found that student academic performance was improved when teachers implement the flipped classroom. To maximize the benefit flipped classroom, there was an educational reform to redesign the course curricula in different disciplines, for example, healthcare (McLaughlin et al., 2014), psychology (Borchardt & Bozer, 2017), and management (Albert & Beatty, 2014). In short, the previous studies indicated that active learning has an impact on students' academic performance.

The current finding would give university administrators and teachers important insights and recommendations to enhance the quality of learning and teaching during the

COVID-19. First, given our finding of the relationship between student's academic performance and active participation, which is initiated by self-learning location-based learning and teaching activity, the thought, which face-to-face teaching will benefit the student most, should be abandoned. We suggested that this vicious cycle could be ended through teachers' continued education and professional development.

Second, educational reform should redesign the course curricula as a new normal learning and teaching practice. By redesigning all kinds of course curricula, we think that universities can maximize students' learning opportunities and outcomes, and more flexible learning and teaching delivery would be most beneficial to students, facilitating students to attend active learning and enhance their learning outcomes.

Various universities have increased the component to inspire students' active learning to apply these and similar findings to maximum effect. For example, 4 universities in the US used asynchronous videos to facilitate student's discussion beyond the class time (Lowenthal et al., 2020). These changes allowed students to interact more with teachers easily. Cardiff University also provided more discussion sessions for students to interact with teachers (Peimani & Kamalipour, 2021). The University of the West Indies designs several self-guided study materials composed of textbooks, digital electronic visual tutors, and asynchronous videos for Introduction to Digital Electronics (George, 2020). Even more, the Department of Sociology at a large northwest university in England (UK) implemented the lecture outside the classroom and facilitated students to make an observation based on the knowledge of sociology (Carlin, 2020).

Moreover, given our findings that students’ academic performance was positively associated with the participation time in the self-learn location-based learning and teaching activity, teachers should adopt the innovative technology to carry out the location-based teaching activity to avoid close contacts pandemic. For example, iBeacon technology would be one of the promising innovative technology. Since iBeacon would be used to deliver information (including message, pre-recorded video, document, or even quiz and test) to mobile by the device’s location automatically, the teacher can provide support to students to minimize their risk. For example, the University of Oklahoma had developed the NavApp, which utilized the iBeacon technology to help students navigate the university library (Hashish et al., 2017). Hence, implementation of iBeacon technology would be extended throughout the campus and provide learning opportunities to students with a minimum number of supporting staff and a tight budget. Another example is the case of ViRLUS (virtual reality learning ubiquitous space) (Konstantinidis, 2021). This system utilizes the Internet of Thing (IoT) and the concept of gamification to allow healthcare students to interact with virtual patients in a real environment. Therefore, it is believed that contactless learning and teaching would have the potential benefit for students (Georgiou & Kyza, 2018; Schneider & Schaal, 2017; Wu et al., 2016).

Conclusion and further direction

In the present study, it is highlighted that iBeacon can contribute to the research by validating previous findings; that is, students' active participation is associated with their academic performance. However, it has several limitations to overcome by future researchers.

First of all, since we employed the cross-sectional study design for current research, the result of the relationship between active participation, academic performance, and user acceptance may not be generalized (Sedgwick, 2014). Future researchers might use a longitudinal study design to understand better the underlying mechanisms driving our theoretical model.

Second, in the present study, the logistic issue arising from the implementation of contactless learning and teaching is not addressed, such as the number of students involved in an activity, the length, form, and content of each learning material. These recommendations may be important to educators and could be covered in future studies.

Third, this study adapted the iBeacon technology to provide self-learn location-based learning and teaching without integrating other innovative technology. The previous literature suggested that AR and VR would amplify the benefit of location-based learning and teaching. Further research might be conducted to compare the benefit of various methods in delivering materials among "Contactless Learning and Teaching".

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