Chapter

The Impact of Academic Discipline on Student's Engagement in Online Learning: An Extension of the Technology Acceptance Model

Ka Long Chan, Roy Kam and Man Sing Wong

Abstract

Tertiary education has dramatically changed after the outbreak of COVID-19. The use of the Learning Management System (LMS) in online learning has become popular. Many researchers are trying to investigate its features that influence the degree of acceptance and usage of learners among those techniques. However, some of their acceptance is not behavioral, but more on mental and abstract, which would be considered as engagement. In addition, academic disciplines would have a different focus on the integration of technology into their teaching and learning, thus, it would influence students' acceptance of the technology. This research addressed this gap by studying university students in Hong Kong about the Technology Acceptance Model (TAM), and behavioral, agentic, cognitive, and emotional engagement. The findings extended the previous literature of TAM by adding engagement and academic discipline into the model. The current study demonstrates that LMS displays the potential of delivering learning and teaching materials amid the pandemic.

Keywords: iBeacon/BLE technology, COVID-19, learning management system, technology acceptance model, engagement

1. Introduction

The sudden outbreak of COVID-19 in China in 2019 during the Spring Festival, has spread rapidly worldwide [1]. The disease spread relatively fast and affected the whole world [2]. The COVID-19 has now become a global issue [3]. Several measures have been taken to prevent physical contact during the pandemic and contain the spread of COVID-19. The most stringent step for epidemic prevention is lockdown [4], which aims to restrict the movement/mobility of people. 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 [5]. Several studies indicated that online learning displays the potential of overcoming course delivery difficulties during the pandemic of COVID-19. For example, Guo [6] found that physics students have a better performance in introductory calculus class as

attending the online sessions than those absent in online sessions and only rely on self-learning materials. More students attending online sessions believe that synchronous online sessions are the same as face-to-face teaching compared to their counterparts since those sessions allow students to interact with the teacher. This implies that engagement during lectures will be an important factor to facilitate students' study.

2. Literature review

2.1 Research on students' technology acceptance of LMS

The use of LMS in online learning become famous during COVID-19. Many researchers are trying to investigate features that influence learners' and educators' degree of acceptance among those technologies [7]. The literature has shown that the Technology Acceptance Model (TAM) is the most adopted theory to investigate the students' technology acceptance. Davis [8] suggested the TAM examine the determinants of users' acceptance for using the technology. Originally, TAM postulated that *perceived usefulness* and *perceived ease of use* are two main factors associated with user acceptance. Perceived usefulness is 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*.

After the publication of Davis [8], 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 [9, 10]. Therefore, the extended model, TAM2 [11], and another subsequent model, UTUAT [12], removed the attitude toward using technology.

Šumak, Heričko [13] conducted a meta-analysis to summarize the TAM-related studies. They found that perceived usefulness and ease of use are two significant factors affecting users' intention to use 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 [14]. They found that both the perceived ease of use and the perceived usefulness have been significantly and positively associated with using the platform. During COVID-19, Siron, Wibowo [15] also found similar results. They used TAM to evaluate the use of e-learning platforms during COVID-19. 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.

However, using the actual usage of technology is not enough to capture the whole picture of their acceptance behavior. Some of the acceptance is not behavioral but mental and abstract, which is considered engagement. Also, academic disciplines would have different emphases in integrating technology into their teaching and learning; thus, it would influence students' acceptance. In the following sections, therefore, we will discuss the relationship between academic discipline, student engagement, and the actual use of LMS.

2.2 Engagement and LMS

Students' academic performance is primarily influenced by student engagement [16]. More recently, researchers have begun to conceptualize student engagement as a multidimensional phenomenon. The review by Fredricks, Blumenfeld [17] identified

three dimensions of engagement: behavioral, emotional, and cognitive. Behavioral engagement refers to students' levels of involvement in the learning activity, including attention, participation, interaction with students and teachers, and spent effort and time. Emotional engagement is defined as students' presence of positive emotional reactions to learning in general, such as value, identity, interest, and happiness, and absence of adverse emotional responses such as anxiety. Cognitive engagement centers on students' self-regulation strategies to employ sophisticated rather than superficial learning strategies in their learning processes. Besides, another review by Kahu [18] used the integrative framework to emphasize engagement as a state influenced by a wide array of teacher and student factors. The framework also acknowledges that students learn through being engaged with their study; thus, learning is not only acquiring skills and knowledge. Build on the previous literature, Reeve [19] also proposed agentic engagement, which is defined as students' attempt to contribute to the learning environment to create for themselves a more motivationally supportive learning environment.

Several studies have found student engagement to be an indicator of students' higher academic achievement. Carini, Kuh [20] found that improvements in students' engagement improve their learning outcomes. Kahu and Nelson [21] assessed students' emotional and cognitive engagement and found that emotional and cognitive engagement can predict academic success. However, online/remote learning has been famous recently, and the question may raise whether students engaging in LMS would benefit academic achievement. For example, Wang [22] examined the relationship between behavioral engagement on Moodle and academic performance (defined as course grade) in a university in Taiwan. Wang found that engagement in problem-solving-related learning activities in Moodle has a direct effect on academic performance. In the studies of Hsiao, Huang [23] and Lee, Park [24], they defined academic performance by GPA and self-developed academic capability measurement, respectively. They also found that behavioral engagement positively correlates with academic performance. This study hopes to extend their findings by assessing whether another type of student engagement, cognitive, emotional, and agentic engagement, also predicts academic performance.

2.3 Academic discipline and LMS

Since the technology advanced, students gradually developed "the information-age mindset" over the three decades [25]. In the meantime, the Learning Management System (LMS) was developed in the 2000s to create a virtual learning environment and facilitate the implementation of online learning (Oblinger & Kidwell, 2000). Since the LMS is a teaching and learning tool, the discussion of LMS has to be informed by pedagogical considerations. As early as 2000, researchers were beginning to identify the influence of LMS on teaching and learning to form the theoretical framework. Coates, James [26] identified some practical problems when the teacher used LMS; one of the dominant problems is that LMS is only used to transmit the text. Teachers did not modify their teaching pedagogy; instead, they employed their traditional teaching approaches when using the LMS [27]. Sadaf, Newby [28] also found similar results in the group of pre-service teachers that use of the LMS would predict the intention to use LMS.

On the contrary, the successful use of LMS depends on the integration between LMS and the subject (including teaching material and learning objective). Research also suggests that different courses emphasize different learning outcomes by providing discipline-specific learning environments [29, 30]. For example, teachers from soft fields tend to focus on facilitating and developing students' ability to discuss alternative and critical perspectives [31]. Those in hard fields tend to focus on having students

memorize and apply essential concepts [32]. Therefore, courses in the same academic discipline would have similar learning objectives; different academic disciplines would have a different level of integration with LMS. Smith, Torres-Ayala [33] investigate the academic discipline as a factor in the instructional design of e-learning. They found that mathematics and nursing/healthcare emphasize learning outcomes and utilization of e-learning tools differently. For example, mathematics focused on the abstract concept of mathematics, whereas nursing/healthcare focused on authentic assessment, which facilitates students to apply the skill and knowledge in real life. White and Liccardi [34] also used Biglan categorization [35] to categorize academic disciplines based on the degree of consensus about knowledge within them. Their categorization classifies disciplines into soft (a low degree of agreement) and hard fields (a high degree of agreement). They found that soft and hard fields have a difference in using LMS tools, which soft fields utilize discussion and simulated virtual environment (role play). In contrast, hard fields utilize real-time visualization tools and assessment.

2.4 Gaps in the literature and the present study

There are several gaps in the literature among students' engagement in online learning. First, the literature's findings focus on behavioral engagement only, which neglects cognitive, emotional, and agentic engagement. Second, previous studies do not differentiate the influence of academic discipline on engagement in e-learning.

This study seeks to address these gaps by combining TAM with engagement and academic discipline. Its theoretical framework is outlined in **Figures 1**–**4**. This study hypothesizes that 1) ease of use has a direct effect on the intention to use, 2) ease of use has an indirect effect through usefulness toward intention to use, 3) positive relationship between students' intention to use and their engagement is stronger in soft fields than in hard fields. Sharma et al. (1981) defined a moderating variable as influencing the relationship's strength and direction between predictors and outcome measures. A moderating variable is different from a mediating variable—the latter accounts for the relationship between

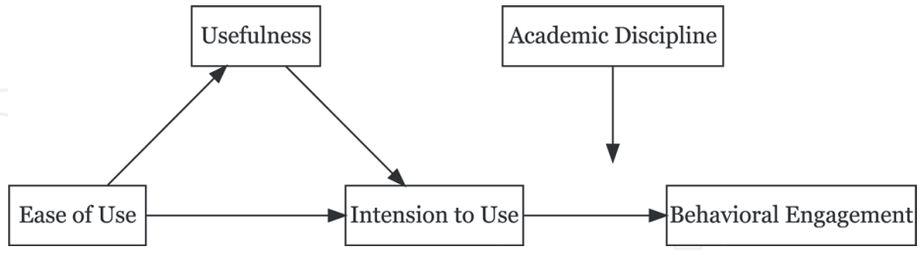

Figure 1.
Hypothetical model of behavioral engagement.

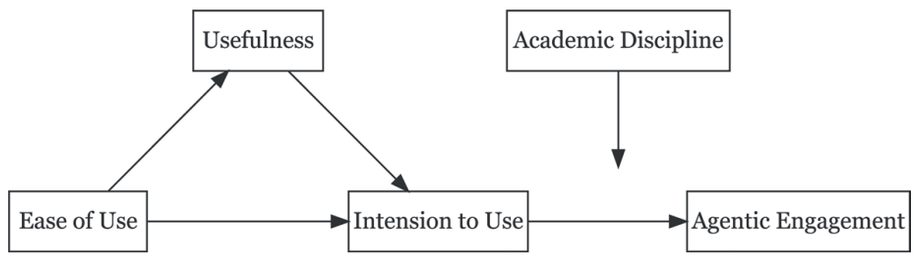

Figure 2.
Hypothetical model of agentic engagement.

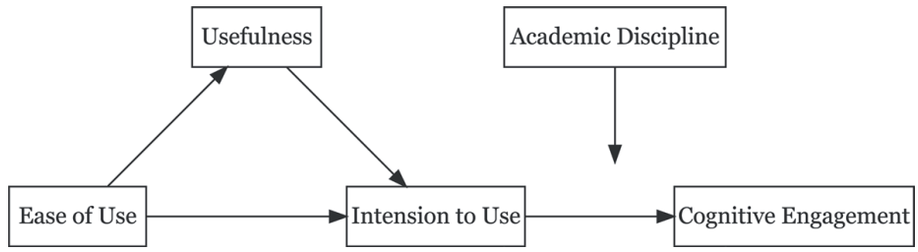

Figure 3.
Hypothetical model of cognitive engagement.

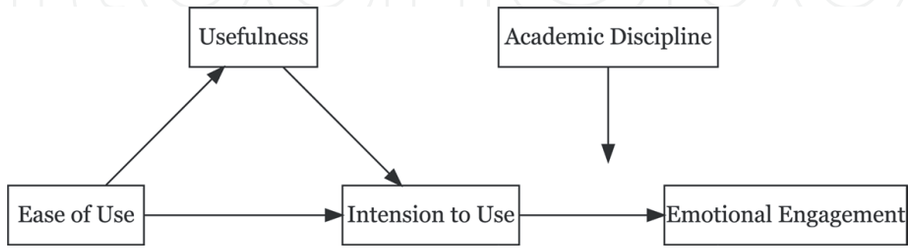

Figure 4.
Hypothetical model of emotional engagement.

predictors and outcome measures [36]. We used regression in our moderation analysis to include the interaction term for both predictors and moderators in our model [37].

3. Method and procedure

3.1 Participants

We recruited study participants from The Hong Kong Polytechnic University, The University of Hong Kong, and The Chinese University of Hong Kong between January and May 2021. A total of 6 courses participated in this study. The research team sent the online survey via Microsoft Form to students at the end of the semester. All of these participants were aged 21–23 years. They had a mobile phone, which shows that the participants were previously mobile users and can be good evaluators of any mobile application. Overall, 68 students responded to the questionnaire. More than 54% of students used the iOS System, and other students used the Android System.

3.2 In-campus and off-campus wholistic learning management system

To overcome the challenge of COVID-19, the project team had developed a system named "Augmented Teaching and Learning Advancement System (ATLAS)" to enhance the teaching quality and student learning experience in the university setting of Hong Kong. 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/. The description of ATLAS is defined as below:

3.2.1 Location-based service

A standalone system for use in conjunction with iBeacon protocol to provide location-based features is being developed. The System is named ATLAS. The purpose

of ATLAS is to empower teachers with the ability to open new streams of engagement, facilitate active participation and communication between students and instructors, and enhance the learning experience in general by providing a holistic platform for contents sharing, discussion, assessment, and engagement.

ATLAS has four main parts: a web-based portal for administration, a student/visitor mobile app for iOS and Android devices, a web-based content management system for instructors, and, lastly, server-side services for the central storage of educational information location-based data collected. The mobile app was developed to utilize an iBeacon-based system to facilitate questions and answers, attendance monitoring, seating location measurement for enhancing teaching and learning outcomes, and activity for "Contactless Learning and Teaching". To achieve "Contactless Learning and Teaching", the teacher 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.

3.2.2 Online teaching and learning

Since there were difficulties in conducting the face-to-face classes under the COVID-19 pandemic, an additional function has been added to the System for teachers and students to use off-campus. Teachers and school administrators can create off-campus classes for the teaching activities. During the remote class, all the location-based features are disabled.

3.3 Measurement

3.3.1 Engagement

We assessed four aspects of student engagement— behavioral, agentic, cognitive, and emotional. We use the engagement scale developed and modified from Reeve's [19] confirmatory factor analysis study, which contained 4, 5, 4, and 4 items for behavioral, agentic, cognitive, and emotional engagement. The items were rated using a five-point Likert scale (1 = strongly disagree and 5 = strongly agree), where Cronbach's alphas were 0.95, 0.92, 0.92, and 0.91, respectively for behavioral, agentic, cognitive, and emotional engagement.

3.3.2 TAM

The usefulness, 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 for usefulness, ease of use, and intention to use. The items were rated using a seven-point Likert scale (1 = strongly disagree and 7 = strongly agree), where Cronbach's alphas were 0.97, 0.88, and 0.94 respectively for usefulness, ease of use, and intention to use.

3.3.3 Academic discipline

We used Biglan [35] classification to divide the academic disciplines into soft (code = 1) or hard fields (code = 2). The categories classify the disciplines into soft (a low degree of agreement) and hard (a high degree of agreement).

4. Data analysis

We performed a path analysis in R studio with the PROCESS macro, version 3.5.3 beta0.6 [38]. **Figures 1–4** display the hypothetical model being tested in the current study. Age and gender were set as covariates. Maximum likelihood (ML) was used to estimate the parameter, and the robust test statistic was reported. To examine the moderated serial mediation effect, we specified 5000 bootstrap samples based on 95% confidence intervals (CIs). A significant conditional indirect effect can be found when the 95% CIs do not include zero. We used a simple slope analysis to visualize the significant interaction between variables [39]. All alpha was set at 0.05, two-tailed.

5. Results

As shown in **Table 1**, participants' average engagement score was 3.92, 3.34, 3.77, and 3.88 for behavioral, agentic engagement, cognitive engagement, and emotional engagement, respectively. About 70% of them were hard fields, and 57.4% of them were female. Nearly 60% of them came from Hong Kong Polytechnic University. The mean scores of usefulness, ease of use, and intention to use were 4.11, 4.78, and 3.84, respectively.

	Mean / N	**SD / %**
Age	20.838	2.477
Gender		
Male	29	42.65
Female	39	57.35
TAM		
Usefulness	4.112	3.118
Ease of Use	4.756	4.022
Intention to Use	3.840	3.055
Engagement		
Behavioral	3.915	0.771
Agentic	3.338	0.822
Cognitive	3.772	0.725
Emotional	3.882	0.770
Academic discipline		
Soft field	20	29.41%
Hard field	48	70.59%
University		
The Chinese University of Hong Kong	19	27.94%
The Hong Kong Polytechnic University	40	58.82%
The University of Hong Kong	9	13.24%

Table 1.
Participant characteristic.

Figures 5–8 show the results of our path analysis. Results showed that "Ease of Use" was significantly associated with "Usefulness" (ß range from 0.863 to 0.864) and "Intention to Use" (ß range from 0.298 to 0.302) in all models. "Usefulness" was also significantly associated with "Intention to Use" (ß range from 0.777 to 0.781) in all models. "Intention to Use" was also significantly associated with behavioral engagement (ß = 0.274), agentic engagement (ß = 0.320), cognitive engagement (ß = 0.253), and emotional engagement (ß = 0.324). Significant interaction effect between students' "Intention to Use" and their academic discipline can predict their emotional engagement scores only (ß = −0.236), there were no significant interaction effect was found in behavioral engagement (ß = −0.171), agentic engagement (ß = −0.169), and cognitive engagement (ß = −0.162). Thus, we performed a simple slope analysis to probe the significant interaction effect. The simple slope analysis revealed no significant relationship between students' "Intention to Use" and their engagement scores in hard fields (β = 0.094) but a significant relationship between these two variables in soft fields (β = 0.252) (**Figure 9**).

Regarding the bootstrap moderated serial mediation analysis, significant conditional indirect effect was found from "Ease of Use" to "Usefulness" to "Intention to Use" to emotional engagement only (Index of moderated mediation = −0.161, 95% CI [−0.293, −0.035]), there were no significant effect was found in behavioral engagement (Index of moderated mediation = −0.119, 95% CI [−0.244, 0.012]), agentic engagement (Index of moderated mediation = −0.118, 95% CI [−0.260, 0.041]), and cognitive engagement (Index of moderated mediation = −0.109, 95% CI [−0.247, 0.024]). Similar to simple slope analysis in emotional engagement, no significant conditional indirect effect was found in hard fields (β = 0.062, 95% CI [−0.029, 0.162]) but a significant effect in soft fields (β = 0.223, 95% CI [0.117, 0.332]).

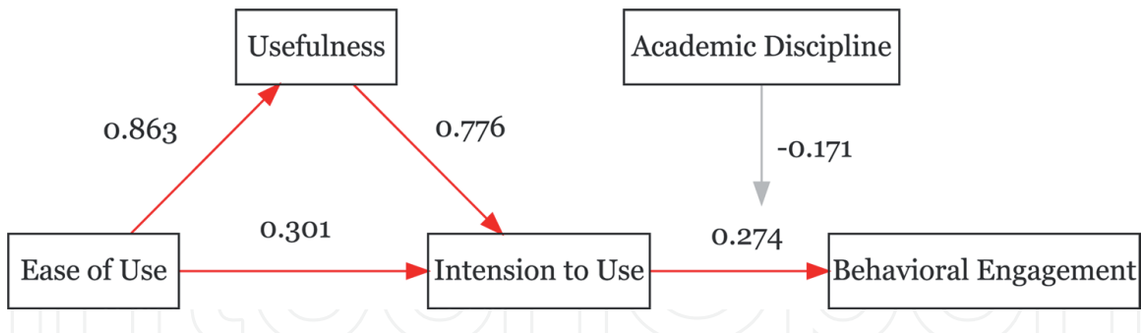

Figure 5.
Path analysis of TAM, academic discipline, and behavioral engagement. Lines in red color indicated significant paths.

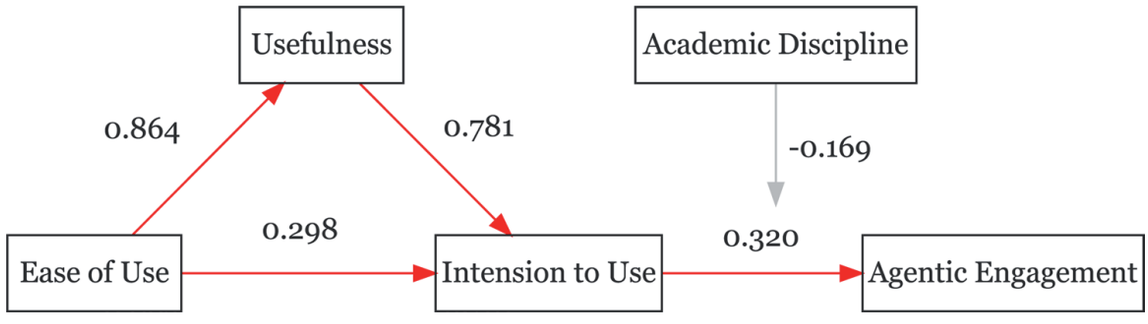

Figure 6.
Path analysis of TAM, academic discipline, and agentic engagement. Lines in red color indicated significant paths.

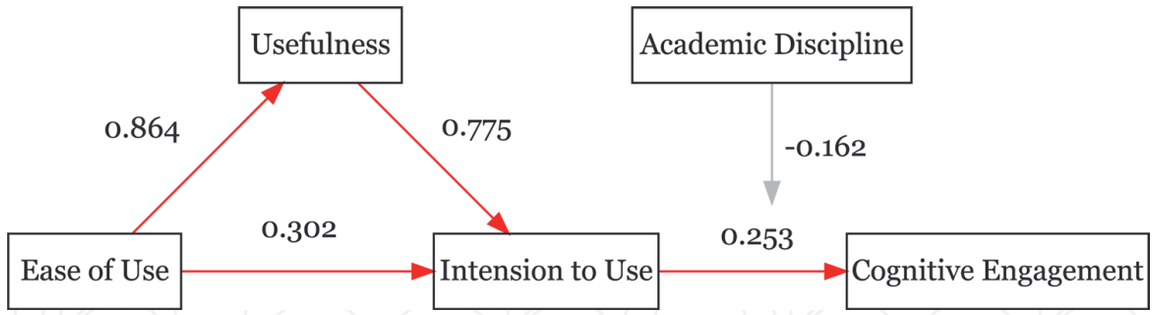

Figure 7.
Path analysis of TAM, academic discipline, and cognitive engagement. Lines in red color indicated significant paths.

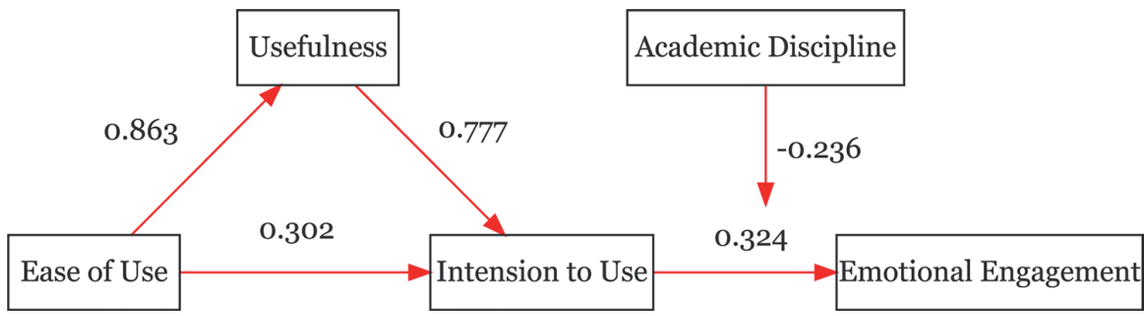

Figure 8.
Path analysis of TAM, academic discipline, and emotional engagement. Lines in red color indicated significant paths.

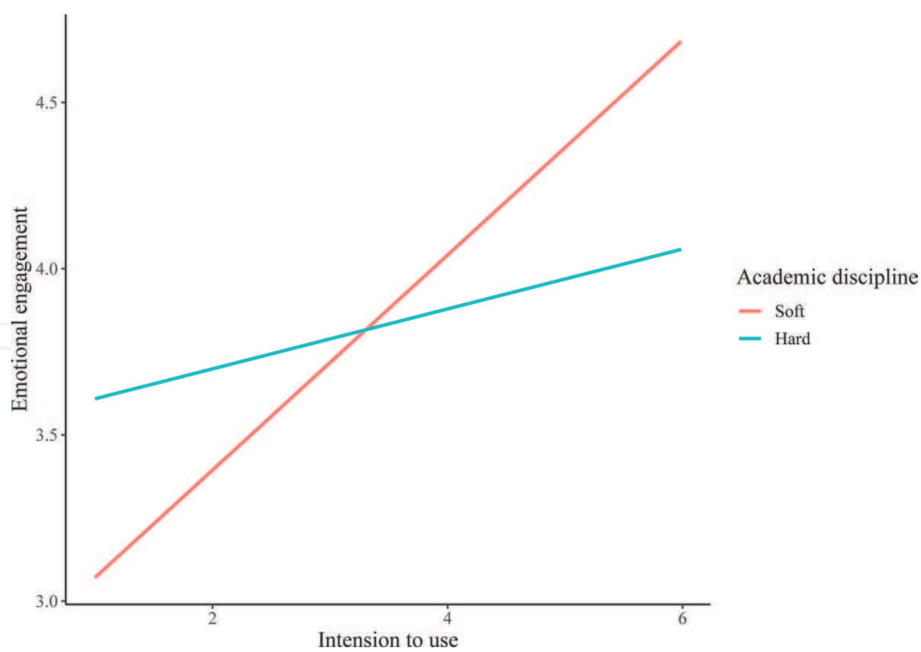

Figure 9.
Relationship between intention to use and emotional engagement among students with the soft and hard field in the academic discipline.

In summary, students from soft fields had higher emotional engagement scores when they had the higher intention to use ATLAS in the future. Students from hard fields' emotional engagement scores did not vary significantly by their "Intention to Use". Regarding behavioral engagement, agentic engagement, and cognitive

engagement, the relationship between students' "Intention to Use" and their engagement scores did not vary significantly by their academic discipline.

6. Discussion

The literature presents many studies where student engagement has been studied from the perspective of behavioral engagement. However, the relationship between agentic, cognitive, and emotional engagement and LMS is an understudied topic. In COVID-19, the use of LMS has become common in the higher education sector, and it has become essential to study it currently. This study explored the relationship between technology acceptance of LMS and engagement with a moderating role for academic discipline.

Study findings add to the literature on the technology acceptance model and students' engagement. Our results are consistent with those of Marangunić and Granić [40] and Al-Emran, Mezhuyev [41]. They noted that ease of use is positively related to the usefulness and intention to use. Aligned with TAM, we expected the usefulness is the mediator from the ease of use to intention to use. Our results align with Tawafak, Romli [42], who found that students with high perceived ease of use among the LMS show higher perceived usefulness. The perception of usefulness leads to a higher intention to use LMS in the future.

Another exciting aspect was that this model operates through the fully online learning platform. Previous studies had investigated the technology acceptance of e-learning platforms [43–45]. Before COVID-19, students used an e-learning platform combined with face-to-face teaching at the same time. The learning does not become highly dependent on the platform and only serves as a supplement. However, face-to-face teaching is suspended and entirely depends on those platforms. Therefore, there is a question of whether the TAM would be applied in this situation. The results align with the above literature on e-learning. Our study recruited participants in a fully online learning undergraduate program, which is different from the previous literature. Therefore, the current study fills the gaps that the experience in a fully online learning program would explain using TAM.

Our study also showed a significant implication in the different types of engagement. Our results were consistent with previous literature [13] that intention to use was associated with the usage of the technology. Also, our current study extended the engagement from behavioral to cognitive, emotional, and agentic. The findings indicate that students without behavioral engagement would also have a high engagement level in other aspects. While comparing the different types of engagement, emotional and agentic engagement had higher effects than behavioral engagement. The results indicate that some of the engagement during the class would be implicit and non-observable. The study makes a case for teachers to be more sensitive toward engagement during the class.

The current study also found a significant moderation effect through academic discipline. The result is aligned with previous literature that there are discipline differences in student engagement [46]. We found that students with the soft field in academic discipline had a stronger relationship between intention to use and emotional engagement than their counterparts. The results were partially consistent with the study of Espejo [47]. Espejo [47] investigated the different types of engagements between classroom characteristics. They found that a learning environment with enough support would facilitate students to engage emotionally and behaviourally.

Our result indicates that students with soft fields are more affected by intention to use and might become more engaged emotionally. However, there are no moderation effect would be found in behavioral, cognitive, and agentic engagement. The insignificant moderation effect would explain that academic disciplines have various effects on the different types of engagement. Different academic disciplines would lead to different learning environments, for example, it is most likely that teachers from the soft field would lead to a person-centered learning environment (reference). Under this learning environment, students would work enthusiastically and enjoy their involvement during the class, even though there are no face-to-face interactions [48]. On the contrary, students would engage in their class behaviorally, cognitively, and genetically at a similar intensity no matter their academic field. This is consistent with the finding that students would engage more with greater teacher support [49]. Therefore, teachers in the hard field could also provide a supportive and interactive learning environment. In aligning with the benefit of an autonomy-supportive learning environment [50], teachers are critical in developing appropriate strategies to heighten the intention to use LMS toward such students and become an autonomy-supporter in facilitating the use of LMS.

This study's findings can provide university administrators and teachers with several important insights and recommendations regarding how to use and redesign the LMS to engage the student. For example, researchers in the University of Hong Kong compared different e-quiz platforms during the class, which the selection of the platform was based on the TAM [51]. They found that the platforms would enhance engagement through friendly competition. The immediate feedback also was perceived as another important component in engaging students to learn since students would perceive the platform as useful for their learning. Researchers at the Chinese University of Hong Kong also examined the impact of digital support on students' engagement [52]. During the learning in LMS, several difficulties about learning materials would be faced by students. In traditional classroom teaching, teachers would provide support for the needs of students. However, the teachers cannot support students all the time when students learn in LMS. Therefore, redesigning the LMS to include digital support based on the TAM would engage students better. Our study and preceding studies mentioned here suggest that several components should be added or platforms should be selected based on the TAM. The more ease to use and usefulness, the better.

7. Conclusion and limitation

The present study extended the TAM by adding cognitive, emotional, and agentic engagement as the outcome; students' acceptance of the ATLAS is associated with the behavioral, cognitive, emotional, and agentic engagement. Academic discipline also modifies the relationship between the acceptance of the ATLAS and emotional engagement. 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 relationship between different types of engagement and user acceptance may not be generalized [53]. Future researchers might use a longitudinal study design to understand better the underlying mechanisms driving our theoretical model.

Second, in the present study, the issue arising from the discipline difference in the engagement is not addressed. Our findings still beg the question of what the

underlying mechanisms are, which drive this moderating effect. Future studies will cover several related factors, e.g., classroom characteristics, pedagogical approach, or learning environment.

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Conflict of interest

The authors declare no conflict of interest.

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