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Students' online learning adaptability and their continuous usage intention across different disciplines

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Online learning, as a pivotal element in modern education, is introducing fresh demands and challenges to the established teaching norms across various subjects. The adaptability of students to online learning and their sustained willingness to engage with it constitute two pivotal factors influencing the effective operation of online education systems. The dynamic relationship between these aspects may manifest unique traits within different academic disciplines, yet comprehensive research in this area remains notably scarce. In light of this, this study constructs an Adaptive Structural Learning and Technology Acceptance Model (ASL-TAM) with satisfaction towards online teaching as the mediating variable to investigate the impact and mechanism of online learning adaptivity on continuous usage intention for students from different disciplines. A total of 11,832 undergraduate students from 334 universities in 12 disciplinary categories in mainland China were selected, and structural equation modeling was used for analysis. The results showed that the ASL-TAM model could be fitted for all 12 disciplines. The perceived ease of use, perceived usefulness, and system environment adaptability dimensions of online learning adaptivity significantly and positively affect satisfaction towards online teaching and continuous usage intention. Satisfaction towards online teaching partially mediates the relationship between online learning adaptivity and continuous usage intention. There were significant differences in the results of the single-factor analysis of the observed variables for the 12 disciplines, and the path coefficients in the ASL-TAM model fitted for each discipline were also significantly different. Compared to the six disciplines under the science, technology, engineering, and mathematics (STEM) category, six disciplines under the humanities category exhibited more significant internal differences in the results of the single-factor analysis of perceived usefulness and the path coefficients for satisfaction towards online teaching. This research seeks to bridge existing research gaps and provide novel guidance and recommendations for the personalized design and distinctive implementation of online learning platforms and courses across various academic disciplines.

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Introduction

With the rapid development of information technology, online learning has become an integral part of modern education. China possesses the largest scale of higher education system and online learning course system globally (National Bureau of Statistics (2020)). However, despite the widespread adoption of online learning platforms, there remain controversies surrounding students' engagement, satisfaction, and willingness to continue using them. Therefore, researching how to enhance students' willingness to persist in using online learning platforms is of paramount importance for the development and promotion of online learning. In recent years, scholars have increasingly focused on the factor of students' online learning adaptability when studying the effectiveness of online learning for students and their willingness to continue using online platforms.

Prior studies have indicated that the overall level of adaptability to online learning among college students is relatively low (Luo, Huang (2012)), and adaptability often becomes a critical factor determining the quality of learning and academic assessment in an online learning environment (D'errico et al., (2018)). However, there is currently insufficient research evidence to fully understand the specific mechanisms through which online learning adaptability affects willingness to persist in using online platforms, necessitating further empirical research.

Moreover, given the extensive use and profound influence of online learning technologies in diverse academic fields (Chikwa et al., (2015)), alongside the marked disparities in online learning outcomes across these disciplines (Ieta et al., (2011)), delving into the intricate interplay between students' online learning adaptability and their inclination to persist in using these tools across various domains becomes particularly instructive. It can provide valuable insights for crafting precise and efficacious online learning strategies and pedagogical models aimed at enhancing student learning outcomes and bolstering students' satisfaction with online education.

As such, this study aims to investigate the impact of online learning adaptability on the willingness to persist in using online platforms among students from different disciplines while exploring the potential mediating effect of their satisfaction towards online teaching. This study randomly selected 11,832 valid samples from 256,504 students attending online learning in 12 disciplines across 334 universities in mainland China. Using structural equation modeling, the study analyzed the comprehensive impact of students' online learning adaptability on their continued use intention of online learning. The study also analyzed the possible mediating effects of satisfaction towards online teaching among the 12 disciplinary categories in the "Degree Granting and Talent Training Discipline Catalog" issued by the Ministry of Education of China.

Theoretical foundation and research hypotheses

Adaptive online learning and continuance intention and their influencing factors. Continuous usage intention is originated from the tracking and evaluation of the continuous use of software programs. It refers to the user's decision to continue using a software application and the frequency of use based on the overall perception of the application. Continuous usage intention is one of the most important user indicators for judging the software system's life cycle. This study applies this factor in the context of online learning research, and forms the concept of "continuance intention of online learning," which is defined as learners' intentions to continue choosing online learning as the primary learning method. This study seeks to determine whether students are willing to continue using this type of learning after a certain period of time.

In contrast to Daumiller et al. (2021), who suggest that teachers' goals and attitudes have a critical impact on students' continuance intention to use online learning, Yao et al. (2022) believe that the key factor affecting continued use of online learning is students' self-awareness, which is closely related to their adaptability to online learning. Online learning adaptability refers to students' ability to adapt to the learning environment by adjusting their learning strategies and adopting adaptive behaviors when using online learning platforms or systems. In the 1980s, Davis (1986) drew on the Theory of Reasoned Action to propose the Technology Acceptance Model (TAM). TAM is primarily used to predict the extent to which individuals are inclined to accept, use, or reject new information technologies (Rogers, 2005). Given that online learning adaptability can help students overcome difficulties and challenges in the learning process, increasing their acceptance and depth of use of online learning, students' adaptability to online learning platforms or systems is likely to be one of the important factors influencing their decision to continue using online platforms.

Online learning adaptability is a complex, multidimensional concept. Generally, it is considered the ability of students to adjust their learning strategies, behaviors, attitudes, goal setting, and resource utilization to adapt to new learning conditions and requirements (Kizilcec et al., 2015). This includes adaptability in areas such as technical proficiency, self-management skills, and information literacy. Among these, the adaptability of university students to online learning primarily depends on their familiarity with the technology tools they use. Therefore, mastering online learning platforms, social media, and digital tools can enhance students' adaptability to online learning (Selwyn, 2011). Additionally, in terms of instructional design, the design of online courses has a significant impact on students' adaptability. Clear learning objectives, organized content, and diverse teaching methods contribute to improving students' adaptability (Picciano, 2017). Providing effective technical support and assistance channels can alleviate students' technological difficulties and enhance their adaptability to online learning (Johnson & Adams, 2011).

In analyzing the issues of online learning adaptability and acceptance, TAM provides several foundational factors, such as perceived ease of use, perceived usefulness, satisfaction, and self-efficacy (Cakır, Solak (2015)). Perceived usefulness and perceived ease of use are generally considered the two most essential variables (Martins et al., 2014). Perceived usefulness refers to the degree to which users believe that using a particular information technology enhances their work efficiency, while perceived ease of use refers to users' perception of how easy it is to operate a specific information technology (Davis, 1989). Alharbi and Drew (2014) argue that perceived ease of use and perceived usefulness in the TAM model significantly positively influence students' intentions to use online learning. Therefore, this study proposes the following hypotheses:

H1a: The perceived usefulness dimension of online learning adaptability has a positive significant impact on students' continued usage intention.

H1b: The perceived ease of use dimension of online learning adaptability has a positive significant impact on students' continued usage intention.

Apart from perceived ease of use and perceived usefulness, there is still no consensus on other important factors influencing continuance intention, especially regarding the strength and mechanisms of different factors (Joo et al., 2011). Liu et al. (2010) suggests that reasonable external extension variables can effectively predict users' intentions to use online learning. Bazelais et al. (2018) and Xu, Lv (2022) also propose considering the

additional effects of external influencing variables in the study of continuance intention. As a frontier and hot topic in online learning research (Jovanovic, Jovanovic (2015)), the theory of Adaptive Learning Systems (ALS) from cognitive psychology proposes the concept of "human-machine interaction adaptability," which includes two aspects: human adaptation to technology and technology adaptation to humans. The latter relies on the "learner model" to automatically analyze learners' cognitive levels and learning styles, and then feedback to the former to enhance learners' learning progress and effectiveness (Retalis, Papasalouros (2005)). Social Cognitive Theory also suggests a similar viewpoint, indicating that students' adaptability is largely influenced by multiple social contexts. A substantial amount of research on ALS also demonstrates that ALS, as a scientific learning medium, can more actively meet students' learning needs (How, Hung (2019)), help correct the learning paths generated by students' autonomous learning habits (Nihad et al., (2017)), and effectively improve students' learning adaptability (Zulfiani et al., (2018)). This study believes that online learning adaptability is a comprehensive, two-way process for students to adapt to changes in the learning environment through self-perception and for software systems to adapt to user needs systematically. It includes three variables: perceived ease of use, perceived usefulness, and system environment adaptability, with the latter referring to the functional adaptability of learning software systems to different learning styles of learners. Therefore, this study proposes the following hypothesis:

H1c: The system environment adaptation dimension of online learning adaptability has a positive significant impact on students' continued usage intention.

Satisfaction towards online teaching and its possible mediating role. Prior research has suggested that satisfaction towards online teaching and perceived usefulness are considered core components in evaluating the effectiveness of online learning (Menon, Seow (2021)), as they relate to the quality of online courses and students' performance (Kuo et al., 2014). Scholars attach great importance to the research on the relationship between students' satisfaction towards online teaching and their continued usage intention, with satisfaction being considered a key element affecting students' continued usage intention and behavior (Lee, 2010).

Among the potential factors contributing to positive adaptability in online learning, perceived usefulness and perceived ease of use are recognized as two significant factors affecting satisfaction (Huang, 2020). Additionally, factors influencing satisfaction can indirectly impact the intention to continue using the system (Bhattacherjee, 2001). Furthermore, online educational platforms with robust system adaptability can provide a more stable network connection, higher-quality learning resources, and a more diverse array of learning pathways. Moreover, they can deliver personalized learning support and teaching resources tailored to individual student needs and learning characteristics. This assists students in overcoming learning challenges and enhances teaching effectiveness, ultimately leading to greater teaching satisfaction. Notably, technological innovations introduced by ALS effectively enhance learners' perceived quality and have a positive indirect influence on teaching satisfaction (Janati et al., (2018)). Therefore, the following hypotheses are proposed:

H2a: The perceived usefulness dimension of online learning adaptability positively and significantly affects students' satisfaction towards online teaching.

H2b: The perceived ease of use dimension of online learning adaptability positively and significantly affects students' satisfaction towards online teaching.

H2c: The system environment adaptation dimension of online learning adaptability positively and significantly affects students' satisfaction towards online teaching.

It is generally believed that students' satisfaction towards online teaching can refer to the indicator system proposed by the research on satisfaction towards classroom teaching, comprehensively evaluating common teaching factors such as course design, learning objectives, teaching methods, teacher qualifications, and interactive experiences. Palmer, Holt (2010) believe that the research on students' satisfaction towards online teaching should pay more attention to the unique factors of the online teaching environment, such as teaching interactivity, technical proficiency, and online self-assessment. Bolliger and Wasilik (2009) also believes that we should start from the key participants in the online environment, focusing on the impact of various aspects such as teachers' information technology application, students' communication level, and school policy and logistical support. Kurucay and Inan (2017) opine that the key factor influencing online learning effectiveness is the interaction between learners. Regarding the main factors influencing learners' satisfaction towards online teaching, Kranzow (2013) believe that the essential factors are related to teacher's online course design level and the ability to respond to student needs in a timely manner. Hogan and McKnight (2007) believe that factors such as the teaching environment and technical support are the main reasons for influencing satisfaction towards online teaching. In addition, there are significant differences in the predicting factors for the acceptance of online learning and satisfaction towards online teaching among university students from different countries (Piccoli et al., 2001). Based on the above research, this study will further analyze the factors influencing learners' satisfaction towards online teaching in the online learning environment, and propose the following hypothesis:

H3: Students' satisfaction towards online teaching positively affects their continued usage intention.

Previous studies have shown that students' satisfaction towards online teaching is likely to be influenced by their learning adaptability, and at the same time affects their intention to continue attending online learning (Waheed, 2010). Therefore, students' satisfaction towards online teaching may play a special mediating role between students' learning adaptability and their continuance intention. Yeung and Jordan (2007) found that factors such as perceived usefulness, perceived ease of use, and service quality evaluation that affect online learning satisfaction also have a positive impact on students' continuance intention. Young (2013) reached similar conclusions and believed that students' satisfaction towards online teaching plays a mediating role in the process of affecting their continuance intention. However, there are also different views about this topic. For example, Troshani et al. (2011) found that although perceived ease of use has a significant impact on learners' usage satisfaction, it does not have a significant impact on their continuance intention. Therefore, the mediating effect of learning adaptability on learners' continuance intention may be extremely important and needs to be verified through empirical research. Therefore, this study proposes that students' satisfaction towards online teaching plays a mediating role between their online learning adaptability and continued usage intention. The specific hypotheses are as follows.

H4a: Students' satisfaction towards online teaching plays a mediating role between perceived usefulness and their continued usage intention.

H4b: Students' satisfaction towards online teaching plays a mediating role between perceived ease of use and their continued usage intention.

H4c: Students' satisfaction towards online teaching plays a mediating role between system environment adaptability and their continued usage intention.

Designing the model framework. As mentioned earlier, it is feasible to use the TAM model to study the sustained usage intention of online learning, and its explanatory power has been verified by empirical studies (Dziuban et al., 2013). However, with the increasing complexity of the online environment, the traditional TAM model may encounter issues with low reliability and validity in explaining complex user environments. Therefore, the academic community has been continuously selecting, combining, and adjusting the basic components of the TAM model. Davis et al. (1992) pointed out that when using TAM theory, multiple external variables, including intrinsic motivation, should be considered, as they may have complex effects on endogenous variables and behavioral intentions. Farahat (2012) found that, in addition to perceived usefulness and perceived ease of use, student attitudes and social influences in online learning are also important factors that influence students' willingness to engage in online learning. Therefore, based on the Technology Acceptance Model (TAM) and the Adaptive Structural Learning Model (ALS), this study combines them to construct the Adaptive Learning and Technology Acceptance Model (ASL-TAM model; see Fig. 1) as follows:

Methodology
Data source. The data for this study were collected from an online learning survey conducted by a Teacher Development Centre of a public university (IRB No. NB-HEC-20200328L) in mainland China from 2020 to 2021. The survey was distributed to students through the academic affairs offices of various schools. Additionally, two lie-detection questions were included in the questionnaire to ensure the validity and reliability of the data. Each student account could only save one survey form. In other words, if the same account answered multiple times, the results of the last response would automatically overwrite the previous ones. A total of 256,504 data sets were collected from 334 universities. Among the surveyed students, there were 110,411 males (43%) and 146,093 females (57%). In terms of geographical distribution, 110,919 students (43.2%) were from the eastern region of China, 106,007 (41.3%) were from the central region, and

38,847 (15.1%) were from the western region. The surveyed students were also classified into different academic disciplines, including 11,086 in philosophy, 20,953 in economics, 7420 in law, 17,100 in education, 24,658 in literature, 1201 in history, 29,517 in natural science, 76,301 in engineering, 5295 in agriculture, 11,161 in medicine, 24,583 in management, and 27,229 in arts. A sample of 1000 student questionnaires was randomly selected from each academic discipline, resulting in a total of 12,000 data sets. The sample was cleaned based on criteria such as lie-detection questions, response times (data below 5 min or above 20 min were removed based on the statistical "3σ rule"), age (data below 15 years old or above 25 years old were removed based on the statistical "3σ rule"), school names (data with randomly filled school names were removed), and whether online learning was used (data indicating no usage were removed). In total, 162 samples were cleaned, resulting in 11,832 valid samples (with 986 for each of the 12 academic disciplines).

Instrumentation. This study was conceptualized based on TAM from the theory of rational behavior and the ALS theory from cognitive psychology. These theories were employed to investigate the underlying mechanisms of the impact of online learning adaptability on users' continuance intention. In this regard, we consulted the research findings of scholars such as Davis (1993), Igbaria (1990), Ajzen & Fishbein (1980), Chen and Tseng (2012), among others. The questionnaire consisted of 33 items measuring five variables (see Table S1 for the complete questionnaire): perceived usefulness (11 items), perceived ease of use (3 items), adjustment to system environments (10 items), satisfaction of teaching (7 items), and continuance intention (2 items). The overall reliability of the questionnaire was tested using the Cronbach's alpha coefficient (0.924), KMO (0.937), and Bartlett's sphericity test ($p < 0.001$) in SPSS 25.0 software, indicating that the questionnaire data were reliable and suitable for exploratory factor analysis (EFA). Three principal components were extracted for perceived usefulness (PU): teaching resources (PU_TR), classroom teaching (PU_CT), and teaching evaluation (PU_TE). Three principal components were also extracted for perceived ease of use (PEU): technical training (PEU_TT), pedagogical training (PEU_PT), and proficiency levels (PEU_PL). Three principal components were extracted for system environment adaptation (SEA): technical service (SEA_TSER), teaching
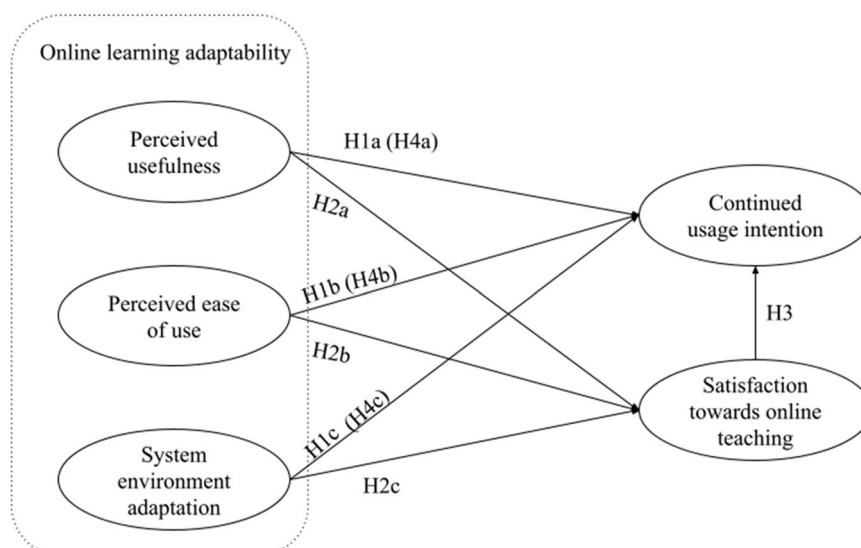
Fig. 1 Adaptive structural learning & technology acceptance (ASL-TAM) model. In ASL-TAM model, online learning adaptability consists of three factors, which are hypothesized to predict continued usage intention and satisfaction towards online teaching.

support (SEA_TSUP), and policy support (SEA_PS). Three principal components were extracted for satisfaction with online teaching (ST): effectiveness of teaching (ST_TE), teaching experience (ST_TEXP), and learning outcomes (ST_LO). Two principal components were extracted for continuance intention (CIN): online mode (CIN_ON) and blended mode (CIN_BL). Perceived usefulness, perceived ease of use, and system environment adaptation were combined to form the independent variable "adaptive structural learning (ASL)" in this study, while satisfaction towards online teaching was the hypothesized mediating variable and continuance intention was the dependent variable. The academic disciplines were treated as control variables. The perceived usefulness and perceived ease of use scales were adapted from Davis (1993), the system environment adaptation scale was adapted from Igbaria (1990), the satisfaction towards online teaching scale was adapted from Ajzen and Fishbein (1980), and the continuance intention scale was adapted from Chen and Tseng (2012).

Research method. Descriptive statistics were conducted on the data of 12 disciplines using SPSS 25.0 software, and model construction, model revision, and model interpretation were carried out using AMOS 24.0.

Results

Reliability analysis. Reliability analysis was conducted on the 14 latent variables across the 12 disciplines using SPSS 25.0 software (see Table 1 for results). The results showed that the alpha values

of the observation variables based on standardized items were all greater than or equal to 0.9, indicating that the questionnaire of the 12 disciplines had high reliability. During reliability analysis, the scores of the latent variables calculated using the mean method also had considerable reliability, indicating excellent data reliability. The data of the 12 disciplines were suitable for further structural model testing.

Common method bias (CMB) test. The data used in this study were collected through self-reporting methods on the internet, which may have CMB. Before formal data analysis, a Harman single-factor test was conducted to examine common method bias. First, exploratory factor analysis (unrotated) was performed using SPSS 25.0 software. The results showed that the first principal component accounted for 29.21% of the variance, which did not meet the 40% threshold.

One-way ANOVA of disciplinary variables. One-way ANOVA analysis was conducted on the observation variables of 12 disciplines. According to the results in Table 2, if the 12 disciplines are viewed as a whole, the evaluation of perceived ease of use (3.62) is higher than system environment adaptation (3.60) and perceived usefulness (3.47). The satisfaction towards online teaching (3.47) is higher than continuous usage intention (3.44). Perceived usefulness is the main weak link of online learning adaptability, and the main observation variable that causes the low value of perceived usefulness is teaching evaluation (3.26). The lowest discipline evaluation value comes from philosophy (3.41). The observation variable with the lowest evaluation value in perceived ease of use is technical training (3.58), and the observation variable with the lowest evaluation value in system environment adaptation is technical service (3.53). The observation variable with the lowest evaluation value in the satisfaction towards online teaching is effectiveness of teaching (3.28). All 14 observation variables of the 12 disciplines showed significant inter-group differences ($p < 0.001$), indicating that there were general differences in the evaluation outcomes among the observation variables of different disciplines.

Table 1 Reliability Analysis of Questionnaire Data.

Subject	Cronbach's alpha	Subject	Cronbach's alpha
Philosophy	0.94	Science	0.92
Economics	0.91	Engineering	0.91
Law	0.91	Agronomy	0.92
Pedagogy	0.92	Medicine	0.92
Literature	0.9	Management	0.92
History	0.91	Art	0.93

Table 2 Univariate Analysis Test of Subject Observation Variables.

Subject		PU_TR	PU_CT	PU_TE	PEU_TT	PEU_PT	PEU_PL	SEA_TSER	SEA_TSUP	SEA_PS	ST_TE	ST_TEXP	ST_LO	CIN_ON	CIN_BL
Philosophy	M	3.59	3.40	3.25	3.42	3.45	3.62	3.42	3.48	3.55	3.21	3.46	3.49	3.06	3.28
	S	1.04	0.94	1.11	1.20	1.18	0.98	0.98	1.08	1.16	1.05	1.00	1.14	1.33	1.32
Economics	M	3.68	3.46	3.28	3.60	3.60	3.71	3.53	3.61	3.67	3.28	3.52	3.58	3.06	3.43
	S	0.82	0.66	0.94	0.89	0.89	0.78	0.70	0.78	0.90	0.85	0.79	0.89	1.20	1.10
Law	M	3.81	3.48	3.22	3.68	3.67	3.81	3.65	3.71	3.79	3.38	3.64	3.72	3.16	3.50
	S	0.83	0.70	1.00	0.93	0.93	0.80	0.71	0.78	0.93	0.87	0.82	0.89	1.24	1.13
Pedagogy	M	3.69	3.49	3.26	3.61	3.61	3.58	3.54	3.63	3.66	3.27	3.53	3.59	3.05	3.50
	S	0.77	0.64	0.89	0.87	0.87	0.75	0.68	0.75	0.90	0.79	0.76	0.85	1.15	1.05
Literature	M	3.71	3.43	3.22	3.58	3.58	3.71	3.54	3.62	3.66	3.26	3.54	3.62	3.04	3.44
	S	0.78	0.62	0.92	0.87	0.87	0.75	0.64	0.72	0.89	0.82	0.76	0.85	1.20	1.09
History	M	3.64	3.41	3.21	3.51	3.51	3.64	3.47	3.55	3.63	3.19	3.47	3.53	2.95	3.42
	S	0.82	0.65	0.91	0.91	0.91	0.77	0.70	0.76	0.97	0.86	0.81	0.90	1.19	1.08
Science	M	3.70	3.50	3.31	3.59	3.59	3.68	3.54	3.63	3.69	3.30	3.55	3.60	3.08	3.46
	S	0.81	0.67	0.93	0.92	0.92	0.79	0.72	0.79	0.92	0.85	0.79	0.88	1.20	1.09
Engineering	M	3.70	3.49	3.30	3.60	3.60	3.75	3.54	3.63	3.69	3.29	3.55	3.61	3.07	3.46
	S	0.84	0.67	0.95	0.94	0.93	0.80	0.73	0.80	0.95	0.88	0.81	0.90	1.22	1.12
Agronomy	M	3.62	3.44	3.26	3.56	3.56	3.66	3.47	3.56	3.62	3.27	3.51	3.55	3.01	3.40
	S	0.82	0.68	0.93	0.92	0.91	0.80	0.73	0.81	0.92	0.85	0.82	0.89	1.20	1.12
Medicine	M	3.71	3.50	3.28	3.57	3.57	3.71	3.50	3.60	3.66	3.22	3.55	3.60	2.95	3.48
	S	0.81	0.65	0.93	0.91	0.90	0.77	0.70	0.78	0.92	0.84	0.79	0.87	1.18	1.08
Management	M	3.70	3.46	3.26	3.60	3.60	3.71	3.54	3.62	3.67	3.28	3.52	3.59	3.07	3.45
	S	0.80	0.66	0.93	0.88	0.89	0.77	0.69	0.76	0.91	0.84	0.79	0.87	1.19	1.09
Art	M	3.69	3.46	3.27	3.67	3.68	3.71	3.60	3.68	3.71	3.37	3.60	3.64	3.17	3.41
	S	0.88	0.75	1.00	0.94	0.94	0.81	0.78	0.84	0.96	0.90	0.87	0.95	1.23	1.14
F		20.63	26.47	19.57	28.61	27.48	77.96	40.45	29.35	20.14	44.59	27.38	22.61	36.86	13.18
p		***	***	***	***	***	***	***	***	***	***	***	***	***	***

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Correlation analysis among variables. To explore the relationships between the variables, a correlation analysis was performed. As shown in Table 3, there were significant positive correlations ($p < 0.001$) between the variables of perceived usefulness, perceived ease of use, and system environment adaptation. There were also significant positive correlations ($p < 0.001$) between the variables of perceived usefulness, perceived ease of use, and system environment adaptation with the mediating variables of satisfaction towards online teaching and continued usage intention. Additionally, there was a significant positive correlation ($p < 0.001$) between satisfaction towards online teaching and continued usage intention.

Model construction and fitting. Based on the ASL-TAM model developed in Fig. 1, a structural equation model was constructed using AMOS 24.0 software, and the initial model was estimated using maximum likelihood. Taking the subject of physics as an example, the results of the initial model fit showed that the correction index MI value of the residual path [e2 < -->e3] was relatively large. Therefore, the initial model was corrected by adding the [e2 < -->e3] residual path, and all path p-values were less than 0.05 after the correction, indicating statistical significance. The fitted model is shown in Fig. 2.

The fitted model for the subject of physics showed good results. The same fitting method was used for the other 11 subjects, and

the results showed that all 12 models could be fitted, and the 12 fitting goodness-of-fit indices were within the standard range. Therefore, the ASL-TAM model can be used for relevant evaluation and prediction work (see Table 4 for goodness-of-fit indices).

Path analysis results of fitted models. The path coefficients of the structural equation can reflect the mutual relationships between latent variables and between latent variables and observed variables. The path coefficients between variables after the fitting of the 12 subjects are shown in Table 5. First, the ASL-TAM models of all 12 subjects can achieve overall convergence. The path coefficients of satisfaction towards online teaching (ST) on continuous usage intention (CIN) are all significant in all 12 subjects, verifying research hypothesis H3. Second, the three paths "perceived ease of use (PEU) → continuous usage intention (CIN)", "perceived usefulness (PU) → continuous usage intention (CIN)", and "system environment adaptation (SEA) → continuous usage intention (CIN)" all display significant path coefficients and can be fitted into the ASL-TAM model, indicating that online learning adaptability and its three dimensions all have a significant positive impact on continuous usage intention (CIN), substantiating research hypotheses H1, H1a, H1b, and H1c. Third, the three paths "perceived ease of use (PEU) → satisfaction towards online teaching (ST)", "perceived usefulness (PU) → satisfaction towards online teaching (ST)", and "system environment adaptation (SEA) → satisfaction towards online teaching (ST)" all display significant path coefficients, indicating that online learning adaptability and its three dimensions all have a significant positive impact on satisfaction towards online teaching (ST), verifying research hypotheses H2, H2a, H2b, and H2c. Additionally, the path "Satisfaction towards online teaching (ST) → continuous usage intention (CIN)" is displayed with a significant path coefficient in all 12 subjects, indicating that "satisfaction towards online teaching (ST)" has a partial mediating effect between "perceived ease of use (PEU)", "perceived usefulness (PU)", "system environment adaptation (SEA)" and "continuous usage intention (CIN)", verifying research hypotheses H4, H4a, H4b, and H4c.

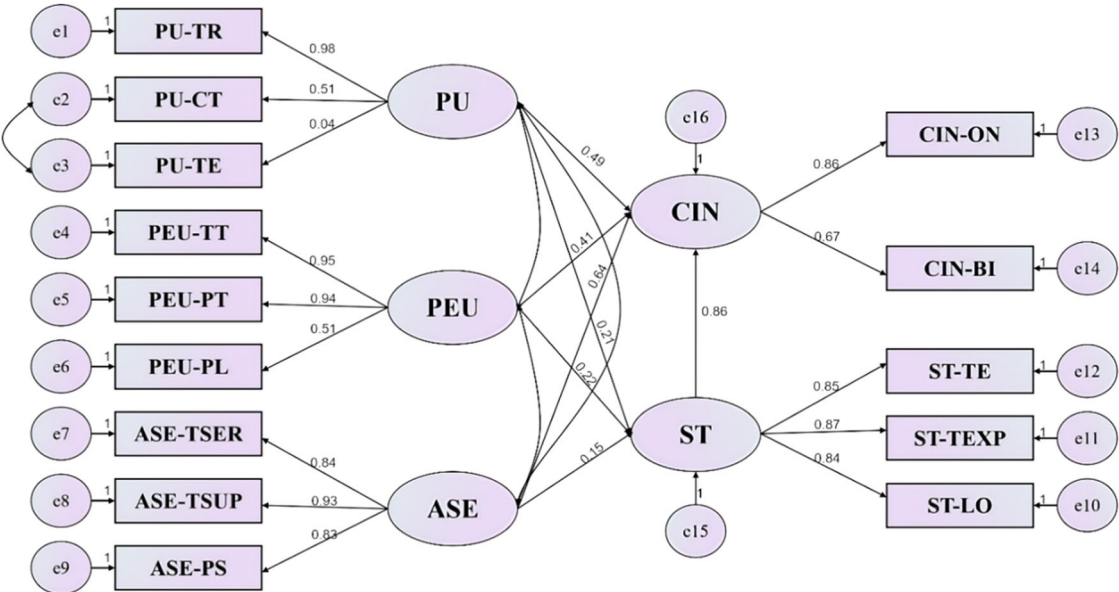| Table 3 Correlation Analysis Among the Variables.					
	1	**2**	**3**	**4**	**5**
1. Perceived usefulness	1.00***				
2. Perceived ease of use	0.68***	1.00***			
3. System environment adaptation	0.71***	0.72***	1.00***		
4. Satisfaction towards online teaching	0.70***	0.67***	0.69***	1.00***	
5. Continued usage intention	0.75***	0.76***	0.74***	0.83***	1.00***

Note: *** $p < 0.001$.

Fig. 2 Adaptive structural learning & technology acceptance (ASL-TAM) model fitting diagram for the science discipline. The validated ASL-TAM model for the subject of physics demonstrated good fit, with most hypotheses being substantiated.

Table 4 Goodness-of-Fit Index of ASL-TAM Models for 12 Disciplines.

Indicator name	Absolute fit index						Value-added fitting index			Comprehensive fitting index		
	p	GFI	AGFI	RMR	RMSEA	ECVI	NFI	CFI	TLI	PNFI	PGFI	CMIN/DF
Standard	<0.01	>0.9	>0.9	<0.05	<0.08	/	>0.9	>0.9	>0.9	>0.5	>0.5	/
Philosophy	<0.001	0.953	0.924	0.045	0.068	0.449	0.971	0.976	0.967	0.694	0.590	5.579
Economics	<0.001	0.936	0.905	0.03	0.073	0.517	0.956	0.963	0.952	0.736	0.624	6.271
Law	<0.001	0.946	0.915	0.039	0.074	0.440	0.961	0.967	0.955	0.714	0.603	6.327
Pedagogy	<0.001	0.946	0.918	0.031	0.066	0.445	0.964	0.971	0.962	0.731	0.622	5.789
Literature	<0.001	0.946	0.916	0.030	0.071	0.418	0.958	0.965	0.953	0.713	0.603	5.098
History	<0.001	0.938	0.904	0.036	0.079	0.490	0.952	0.958	0.945	0.720	0.608	6.198
Science	<0.001	0.938	0.906	0.036	0.075	0.532	0.960	0.966	0.955	0.728	0.616	6.557
Engineering	<0.001	0.937	0.904	0.039	0.073	0.509	0.958	0.965	0.953	0.727	0.616	6.229
Agronomy	<0.001	0.940	0.910	0.031	0.073	0.516	0.960	0.966	0.955	0.738	0.627	6.255
Medicine	<0.001	0.942	0.911	0.034	0.071	0.488	0.962	0.968	0.958	0.729	0.619	5.927
Management	<0.001	0.945	0.916	0.030	0.067	0.453	0.964	0.970	0.961	0.731	0.621	5.426
Art	<0.001	0.938	0.907	0.030	0.073	0.511	0.966	0.971	0.962	0.743	0.625	6.195

Table 5 Path Coefficients of 12 Discipline Fitting Models.

Path	Philosophy	Economics	Law	Pedagogy	Literature	History	Science	Engineering	Agronomy	Medicine	Management	Art	P
ST < -PU	0.22	0.56	0.69	0.62	0.73	0.61	0.64	0.67	0.60	0.61	0.66	0.57	***
ST < -PEU	0.42	0.24	0.20	0.22	0.17	0.23	0.21	0.18	0.24	0.22	0.19	0.24	***
ST < -SEA	0.32	0.18	0.14	0.16	0.10	0.16	0.15	0.13	0.17	0.16	0.14	0.19	***
CIN < -ST	0.69	0.64	0.59	0.70	0.63	0.62	0.86	0.70	0.65	0.63	0.68	0.65	***
CIN < -PU	0.21	0.71	0.51	0.47	0.56	0.44	0.49	0.51	0.39	0.44	0.37	0.38	***
CIN < -PEU	0.33	0.18	0.24	0.37	0.25	0.31	0.41	0.19	0.32	0.29	0.45	0.31	***
CIN < -SEA	0.22	0.33	0.31	0.29	0.30	0.31	0.22	0.33	0.31	0.29	0.30	0.31	***
PU_TR < -PU	1.48	1.01	0.90	0.95	0.93	0.96	0.98	0.97	0.96	0.96	0.95	0.98	***
PU_CT < -PU	1.20	0.48	0.43	0.57	0.53	0.52	0.51	0.45	0.54	0.55	0.58	0.58	***
PU_TE < -PU	0.68	0.06	0.00	0.08	0.00	0.00	0.04	0.04	0.09	0.03	0.08	0.12	***
PEU_TT < -PEU	0.93	0.90	0.95	0.93	0.93	0.93	0.95	0.95	0.91	0.93	0.95	0.95	***
PEU_PT < -PEU	0.92	0.90	0.96	0.95	0.95	0.94	0.94	0.93	0.93	0.94	0.92	0.95	***
PEU_PL < -PEU	0.61	0.52	0.48	0.45	0.42	0.48	0.51	0.45	0.54	0.47	0.50	0.57	***
SEA_TSER < -SEA	0.87	0.84	0.88	0.85	0.82	0.84	0.84	0.85	0.87	0.87	0.84	0.89	***
SEA_TSUP < -SEA	0.95	0.92	0.91	0.91	0.90	0.92	0.93	0.89	0.92	0.92	0.91	0.93	***
SEA_PS < -SEA	0.82	0.78	0.77	0.78	0.71	0.74	0.83	0.76	0.78	0.81	0.74	0.84	***
ST_TE < -ST	0.85	0.80	0.79	0.80	0.79	0.83	0.85	0.81	0.81	0.80	0.84	0.87	***
ST_TEXP < -ST	0.91	0.91	0.87	0.88	0.86	0.86	0.87	0.88	0.90	0.91	0.89	0.91	***
ST_LO < -ST	0.86	0.83	0.85	0.86	0.83	0.79	0.84	0.84	0.84	0.86	0.84	0.85	***
CIN_ON < -CIN	0.76	0.82	0.77	0.70	0.74	0.80	0.86	0.76	0.76	0.73	0.76	0.85	***
CIN_BL < -CIN	0.75	0.72	0.69	0.73	0.71	0.75	0.67	0.74	0.71	0.73	0.72	0.73	***

Note. ***p < 0.001.

Discussion

This study confirms the positive impact of online learning adaptability on users' intention to continue using the platform. This aligns with previous research findings that students' adaptation to a course significantly affects their learning outcomes (Manwaring et al., 2017). Unlike most studies that only focus on students' one-way adaptation to the teaching system, this study confirms that both students' "perceived adaptation" to the system and the system's "adaptive needs" to the students are equally important and should be considered as a whole. When students' perceived position in the system matches the target characteristics predicted by the system, they will rate the teaching activities higher (Bretschneider et al., 2012).

This study also confirms the positive impact of online learning adaptability on satisfaction towards online teaching, which is in line with previous research that adaptability is an important indicator of students' learning satisfaction, perceived utility, and intention to continue learning (Machado, Meirelles (2015)). Therefore, adaptability should be the logical starting point for designing online learning systems. At the same time, enhancing the intelligence perception of "human-computer interaction" and improving the teaching adaptivity of "teacher-student interaction" are important directions for enhancing users' intention to

continue using online learning and improving the overall quality of online learning.

This study also confirms the positive impact of satisfaction towards online teaching on users' intention to continue using the platform, and the TAM model is applicable in evaluating satisfaction and intention to continue using in 12 subject areas. The adaptive structural learning and technology acceptance model fit successfully in all 12 subject areas. This confirms that the TAM model can be used to explain the factors that influence learners' acceptance of online learning (Venkatesh, Davis (2000)), and the core structure of TAM has a significant impact on users' intention to continue using (Natasia et al., 2022).

Furthermore, this study confirms that satisfaction towards online teaching partially mediates the relationship between online learning adaptability and users' intention to continue using the platform. The ASL-TAM model developed in this study reveals that there are expression differences in the factors that affect satisfaction towards online teaching and users' intention to continue using in the 12 subject areas, and the ASL-TAM model can explore the deep path reasons for the expression differences in the factors affecting users' intention to continue using (Al-Azawei, Lundqvist (2015)), and then analyze the educational goals and methods paths for implementing online learning in different subjects.

This study has three contributions. First, the study found that perceived usefulness (PU) (3.47) was lower than system environment adaptation (SEA) (3.60) and perceived ease of use (PEU) (3.62). The continuous usage intention (CIN) (3.44) was lower than satisfaction towards online teaching (ST) (3.47). The main observed variables leading to a low evaluation of perceived usefulness (PU) were teaching evaluation (PU_TE) (3.26) while the lowest evaluated variable in perceived ease of use (PEU) was technology training (PEU_TT) (3.58). In system environment adaptation (SEA), the lowest evaluated variable was technical service (SEA_TSER) (3.53) while the lowest evaluated variable in satisfaction towards online teaching (ST) was teaching effectiveness (ST_TE) (3.28). This indicates that online education in mainland China is still in the early stage of hardware facilities configuration and teaching technology training. The continuous usage intention (CIN) is generally weak, possibly due to the weak links in the early adaptation to online learning, which affects the evaluation of satisfaction towards online teaching (ST), leading to a weaker overall continuous usage intention (CIN). Online learning needs more specific and effective project support (Ramadhan et al., 2021).

Second, the study confirms that satisfaction towards online teaching (ST) plays a partial or complete mediating effect between perceived ease of use (PEU), perceived usefulness (PU), system environment adaptation (SEA) and continuous usage intention (CIN), which confirms previous research conclusions. That is, user satisfaction is a key antecedent to influence user intention to continue use and behavior (Igbaria et al., 1997). There are many possible factors that influence continuous usage intention (CIN) of a teaching method, but among various factors, satisfaction towards online teaching (ST) of the student population is the "central factor", especially for online education, learner satisfaction is considered a key factor for teaching success (Joo et al., 2011). It is also important to strengthen system environment adaptation (SEA) based on human-computer interaction, as online learning requires an attractive and motivational external environment (Agyeiwaah et al., 2022), and satisfaction may vary due to internet experience (Reed, 2001).

Thirdly, this study confirms the significant differences in satisfaction towards online teaching (ST) and continuous usage intention (CIN) between STEM and humanities disciplines. Influenced by the early college entrance examination system, China has conventionally classified disciplines into STEM and humanities, similar to the "arts" and "science" branches in the subject guidelines of Western universities. The classification not only affects the disciplines but also results in significant differences in academic literacy among students in different fields. This study found that compared to STEM disciplines (such as natural science, engineering, agriculture, medicine, and management), the six traditional humanities disciplines, namely philosophy, law, education, literature, history, and economics, showed extremely significant differences in perceived usefulness (PU), which may be due to the difference in teaching style between humanities and STEM (Tuimur et al., 2012) and the peer cultural influence within the humanities. A study of nearly 500,000 online courses in the state of Washington in the United States has similar conclusions that students face greater difficulties in online learning in fields like English and social sciences, possibly due to the existence of "negative peer effects" in the online courses of these disciplines (Lv et al., 2022).

Implications. In order to enhance the satisfaction towards online teaching and continued usage intention of online education, this study proposes the following suggestions:

From the perspective of cognitive psychology, the differences in online teaching among different disciplines are mainly manifested in various aspects such as the cognitive perspectives and learning habits of students with different disciplinary backgrounds. From the standpoint of educational technology theory, there is a need for continuous development of multidimensional and multilevel teaching systems to adapt to the knowledge structures, teaching principles, and curriculum characteristics of different disciplines. Furthermore, constructivist learning theory emphasizes that teachers should assist students in improving their learning adaptability more actively and in constructing knowledge and meaning more proactively. This study empirically validates the above viewpoints and provides new discoveries. Research shows that there are significant differences in satisfaction towards online teaching and continued usage intention in online learning among different subjects, so different online learning for different subjects should be implemented. On the one hand, the convergence of online learning in different subjects should be grasped, and a wide-caliber, widely applicable teaching platform carrier should be constructed to effectively integrate different subject knowledge into the virtual classroom knowledge situation, and better promote the integration of knowledge and skills. On the other hand, attention should be paid to the objective differences of different subjects, and an online education system reflecting the advantages of different subjects should be designed according to the teaching contents of different subjects.

From the perspective of practicality, it is necessary to pay close attention to the significant differences among various disciplines in terms of subject content and learning objectives, teaching methods and learning activities, assessment and feedback methods, as well as the roles of teachers and technological support. It is important to actively develop teaching methods that are tailored to different disciplines, especially in the case of experimental courses. Compared with traditional classroom education, the important breakthrough of online learning is the more convenient and timely teaching feedback. Future online learning systems should create adaptive learning environments based on the different characteristics of learners (Park and Lee, 2003), and accelerate the construction of adaptive learning systems for college students with different learning methods in different subjects, which is an effective solution to the conflict between diversified subject needs and static teaching resources, and an important way to resolve the contradiction between diversified student levels and limited teaching resources. For science and engineering subjects, attention should be paid to improving the external environment of online learning, actively improving online learning performance evaluation, promoting industry-university-research cooperation, promoting demand docking, resource sharing, and complementary advantages, promoting industry-education integration and industry-university co-construction, and achieving win-win results for teachers and students. For humanities subjects, the technical support for each link of online learning should be improved, and more humanistic care should be reflected in interactive teaching support. Through more social integration, knowledge exploration-based social consultation can be promoted.

In terms of the broader external educational environment and technological development trends, we should emphasize the opportunities for educational technology innovation and industry-education integration brought about by the differential development of online teaching in various disciplines. Clearly, the issue of disciplinary differences presents challenges in terms of teaching organization and operation, but it also promotes opportunities for personalized learning, collaborative teaching, and diversified assessment. China is already a major player in online education, but it is not yet a powerhouse in this field. To

unleash the educational value of online learning and expand its innovative significance, online education, represented by flipped classrooms and MOOCs, not only provides new teaching methods and educational pathways, but also brings innovative educational ideas and paradigms. Therefore, online education needs to emphasize the re-examination of external contexts, overcome the mechanical thinking of "100% replication of classroom education," and explore new teaching paths and operating modes, providing teachers and students with more novel teaching experiences and promoting the comprehensive improvement of their knowledge, abilities, and qualities.

Limitations and future research. This study has two limitations. Firstly, to increase the credibility of the research conclusions, we have tried to increase the sample size, resulting in a relatively large number of universities involved in the study. These universities may have differences in their discipline settings and standards, which may introduce some errors that need to be addressed in future research. Secondly, previous studies have shown that factors such as the location of the participants, the level of their universities, and their academic year may affect their satisfaction with teaching. We were unable to eliminate these possible interferences in this study and will improve this in future research.

Data availability

The data presented in this study are available on request from the corresponding author. According to the regulation of the Ethics Committee of Ningbo University, the data are not publicly available due to ethical reasons as they contain personally identifiable information.

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ZL: Conceptualization, supervision, resources, writing review and editing; XL and MC: Data curation, writing original draft preparation; SL: Data curation; CL: Resources, writing review and editing, supervision; SS: Conceptualization, methodology, formal analysis, writing original draft preparation; LL: Methodology, writing review and editing.

Ethical approval
This project was approved by the Ethics Committee of Ningbo University.

Informed consent
Informed consent was obtained from all subjects involved in the study.

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The authors declare no competing interests.

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