

## The mediating role of technology acceptance and moderating role of emotion regulation in faculty's online professional development

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Higher education faculty members have different attitudes about taking professional training courses online despite the post-pandemic shift towards e-learning. Limited studies have linked faculty's emotions with their acceptance of technology and investigated their impacts on learning engagement in online professional development. This study addresses this gap by testing the mediating effect of technology acceptance between learning-related emotions and online learning engagement in professional development and the moderating effect of emotion regulations therein. The study is theoretically grounded in control-value theory, unified theory of acceptance and use of technology, alongside the process model of emotion regulation. After collecting data from 254 higher education faculty members (146 females) through an online questionnaire, the study applied a partial least squares structural equation model for its results. The findings show that learning-related emotions are associated with technology acceptance, while emotion regulation plays a moderating role. The results further show that technology acceptance mediates between learning-related emotions and online learning engagement. The findings identify a need to attend to faculty's emotional dimensions in online learning and stress the importance of emotionally embracing technology in learning engagement among faculty.

### *Implications for practice or policy:*

- Instructors should provide appropriate emotional support to faculty.
- Designers should include pre-session courses in the curriculum to introduce the value and ease of using learning technologies.
- Higher education institutions should offer training to enhance faculty's abilities to regulate their emotions.
- Higher education institutions should provide accessible, stable and reliable learning technologies along with an inclusive and supportive culture for online professional development.

*Keywords:* online professional development, learning-related emotions, emotion regulation, technology acceptance, online learning engagement

## Introduction

Professional development (PD) is important for higher education (HE) faculty (Wynants & Dennis, 2018), as many faculty tend to focus on their disciplinary interests rather than their pedagogical strategies and practices (Brancato, 2003; Wynants & Dennis, 2018). Due to rapid growth in technology, many PD programmes are now offered online (Teräs, 2016), enabling faculty to engage in learning more flexibly, with fewer space and time constraints (Al-Bargi, 2021; Wynants & Dennis 2018). Online PD has gained popularity over the past 2 decades (King, 2002; Powell & Bodur, 2019) with many universities offering the option of completing PD online (Al-Bargi, 2021; Mulla et al., 2020). However, access to online education does not guarantee active use of such learning resources or high-level learning engagement (Gibson et al., 2008; Ma et al., 2022). For online learning success, the priority needs to shift from ensuring online learning readiness to learners' actual acceptance and engagement (He et al., 2023).

Online learning engagement has been identified as a strong predictor of learning achievement, programme completion rates and learning persistence (Kala & Chaubey, 2022; Luan et al., 2020). Scholars have suggested that learning engagement is a key factor in measuring the quality of online learning programmes (Rajabalee & Santally, 2021; Zhoc et al., 2022). Several factors have been shown to affect the level of engagement in online learning, among which emotions (Artino & Jones, 2012; Dubovi & Adler, 2022) and technology acceptance (Kala & Chaubey, 2022; Ustun et al., 2021) are considered indispensable. How online learners' emotions and technology acceptance affect online learning engagement (e.g., Artino & Jones, 2012; Tseng et al., 2020) has separately been explored. In recent years, researchers have started linking learners' emotions with learners' technology acceptance in online learning. For example, Chao (2019) has suggested that positive emotions (i.e., perceived enjoyment) promote learners' technology acceptance. However, few studies have explored how technology acceptance is impacted by online learning-related emotions, with most research focusing on learners' perceived emotions towards using technologies (C. Wu et al., 2021). Additionally, how online learners' emotion-related antecedents impact their learning engagement through the influence of technology acceptance remains unknown. This study aims to fill this gap by testing the effect of faculty's learning-related emotions on technology acceptance first and then investigating how their learning-related emotions influence their learning engagement through their technology acceptance in online PD.

Studies have suggested that effective emotion regulation can positively influence individuals' attitudes towards handling technology-related challenges (e.g., Beaudry & Pinsonneault, 2005; Regan et al., 2012). In our study, emotion regulation refers to the strategies used by faculty to proactively regulate emotions that arise during their online PD. Emotion regulation enables individuals to effectively manage emotion dynamics (Thompson, 1990) they experience in completing online learning. By regulating emotions, people can foster more positive emotions and reduce negative emotions (Pekrun et al., 2011; Pekrun & Stephens, 2009; Zhao et al., 2021) to gain a better online learning experience. No studies have investigated how faculty's emotion regulation influences the relationship between their online learning emotions and technology acceptance. Our study addresses this gap by examining the role of emotion regulation in the relationship between faculty's learning-related emotions and technology acceptance.

The following questions informed this study:

- (1) How do faculty's learning-related emotions impact their technology acceptance and learning engagement?
- (2) How (if any) does faculty's technology acceptance mediate the relation between their learning-related emotions and learning engagement?
- (3) How (if any) does faculty's emotion regulation moderate the relation between their learning-related emotions and technology acceptance?

## **HE faculty's learning-related emotions and learning engagement in online PD**

Pekrun et al. (2002) framed emotions in academic contexts according to their associations with achievement, suggesting that emotions exist in the process of reaching achievement (e.g., studying) and outcomes of achievement (e.g., success and failure). Later, Pekrun et al. (2011) divided achievement emotions based on three commonly occurring academic scenarios: learning-related emotions, class-related emotions and test-related emotions. For online PD, learning-related emotions are most relevant. In online PD sessions, emphasis is often placed on instruction and imparting knowledge (Cong, 2023; Wynants & Dennis, 2018), with tests not usually part of the aims. Moreover, physical class-based emotions are considered distinct from emotions in online learning environments, as online PD is often asynchronous and self-regulated (Cong, 2023; King, 2002). Learning-related emotions emerge as learners complete a series of learning activities (Pekrun et al., 2006), such as watching videos, reading material and participating in forum discussions in the online setting (Ma et al., 2022). Learning-related emotions are categorised according to valence as positive or negative, with a list of specific emotions in each type (Pekrun, 2006; Pekrun et al., 2006). Learners' emotions impact their ability to understand and process information, memorise information and perform reasoning practices (Merriam et al., 2007). Positive learning-related emotions positively impact learners' cognitive processing (Kuhbandner & Pekrun, 2013), while negative ones can predict learners' attention problems, low levels of motivation and self-regulation (Pekrun et al., 2010).

Learning engagement is measured by the willingness and effort that learners devote to participating in learning activities (Coates, 2006; Hu & Hui, 2012). Higher levels of engagement often improve learning performance and achievement (Lei et al., 2018). Initially, scholars suggested that learning engagement consists of three components: behavioural, emotional and cognitive (Hew, 2016). Behavioural engagement is defined as learners' on-task attention, effort and persistence in learning-related activities. Emotional engagement refers to learners' affective attitudes or feelings towards their teachers, peers, courses and the entire learning process. Cognitive engagement refers to the learners' use of learning strategies and self-regulation (Buelow et al., 2018). Reeve and Tseng (2011) added agentic engagement as a fourth aspect of learning engagement to reflect learners' motivation to learn and their active contribution to learning activities.

Studies have shown that positive emotions in the online learning context are positively related to learning engagement (e.g., D'Errico et al., 2016; Y. Wang et al., 2022). However, researchers have also suggested that different negative emotions will lead to different results in learning engagement in an online context. Moreover, divergent findings have been reported regarding the impact of the same specific negative emotions on online learning engagement. For example, Dubovi and Adler (2022) claimed that anxiety and boredom resulted in reduced engagement in an online course during the COVID-19 pandemic. Artino and Jones (2012) indicated that frustration could motivate learning in an online context; however, C. Wu et al. (2021) proposed that boredom and frustration in online learning are unrelated to learning engagement, thus showing conflicting results. Since no research has examined this relationship in the context of online PD, our research focuses on testing faculty's positive and negative learning-related emotions as a cluster and their collective impact on learning engagement. It is important to understand the effects of each emotion cluster in a particular setting before examining the specific emotions of each cluster (Artino & Jones, 2012).

## **The mediating role of technology acceptance**

Technology acceptance is considered as an essential factor in ensuring the effective implementation of new information technologies and the use of technology to improve productivity (Venkatesh et al., 2003; C. Wu et al., 2021). One common model to measure technology acceptance is the unified theory of acceptance and use of technology (Venkatesh et al., 2003), which has been applied to online learning (Isaias et al., 2017). This model measures users' behavioural intentions and acceptance of technology according to determinants including performance expectancy (i.e., belief in the technology's usefulness in improving performance), effort expectancy (i.e., perceived ease of using the technology), social

influence (i.e., perception of important people's attitudes towards the technology) and facilitating conditions (i.e., perception of support and resources for technology use) (Venkatesh et al., 2003).

Scholars have established a relationship between emotions and acceptance of technology. C. Wu et al. (2021) have found that positive and negative learning-related emotions affect pre-service teachers' acceptance of technology. Tao et al. (2022) have suggested that when learners consider their online learning experience enjoyable, they are more likely to believe in the ease and usefulness of the learning technologies, thus increasing their intention to use them. Learners' higher technology acceptance has also been shown to contribute to higher online learning engagement (Kala & Chaubey, 2022; Tseng et al., 2020; Ustun et al., 2021). When learners hold a positive attitude towards online learning technologies, the technologies serve as effective tools to engage learners in-class learning activities (Ustun et al., 2021). Furthermore, learners with higher technology acceptance show higher confidence in their ability to confront challenges in online learning, further facilitating their online engagement (Tseng et al., 2020).

### **The moderating role of emotion regulation in online PD**

Gross (1998) defined emotion regulation as the process through which people decide what emotions to feel, how they experience these emotions and what they do to express and control their emotions. Emotion regulation can shape learning experiences by enabling learners to increase positive and reduce negative emotions, thereby maintaining motivation for learning and improving performance (Bielak & Mystkowska-Wiertelak, 2020; Pekrun et al., 2011; Pekrun & Stephens, 2009; Tang & He, 2022). Gross (2001) proposed two predominant emotion regulation strategies: cognitive reappraisal (reappraisal) and expressive suppression (suppression). Reappraisal is an antecedent-focused strategy, whereby people change their way of evaluating certain emotion-eliciting situations before unwanted emotions occur; suppression is a response-focused strategy, whereby people modify their behaviours as an emotional response to certain events after emotions appear (Gross, 2001).

Several empirical studies have validated the functions of emotion regulation in online learning settings. Tang and He (2022) found that effective emotion regulation, including both reappraisal and suppression, provide strong support to maintain positive emotions such as satisfying feelings in learning. Zhang et al. (2021) indicated that the use of a reappraisal strategy can generate enjoyment when language learners perceive their learning as positive and receive positive feedback in learning. Zhao et al. (2021) found that the suppression strategy causes higher anxiety for online learners. Thus, emotion regulation contributes to different emotional experiences in online learning. In terms of the correlation between emotion regulation and technology acceptance, although no study has directly examined this relation, individuals with higher levels of emotion-coping ability are more likely to show confidence in and positive attitudes towards their ability to control unfamiliar technology-related situations (Beaudry & Pinsonneault, 2005). The literature provides the theoretical underpinning to propose the moderating role of faculty's emotion regulation in the relationship between learning-related emotions and technology acceptance in online PD.

### **Hypotheses**

Based on the literature, we proposed hypotheses H1–H5 to validate the existing understanding of the relations between emotions, technology acceptance and online engagement in online PD; H6 and H7 examined the mediating role of technology acceptance between learning-related emotions and online engagement; H8 and H9 considered the moderating role of emotion regulation in online PD:

- H1: Faculty's positive learning-related emotions are positively associated with technology acceptance.
- H2: Faculty's negative learning-related emotions are negatively associated with technology acceptance.
- H3: Faculty's positive learning-related emotions are positively related to online learning engagement.

- H4: Faculty's negative learning-related emotions are negatively related to online learning engagement.
- H5: Faculty's technology acceptance is positively related to their learning engagement.
- H6: Faculty's technology acceptance mediates the relation between their positive learning-related emotions and online learning engagement.
- H7: Faculty's technology acceptance mediates the relation between their negative learning-related emotions and online learning engagement.
- H8: Faculty's emotion regulation moderates the relation between their positive learning-related emotions and technology acceptance.
- H9: Faculty's emotion regulation moderates the relation between their negative learning-related emotions and technology acceptance.

Figure 1 illustrates a simplified conceptual model of this study.

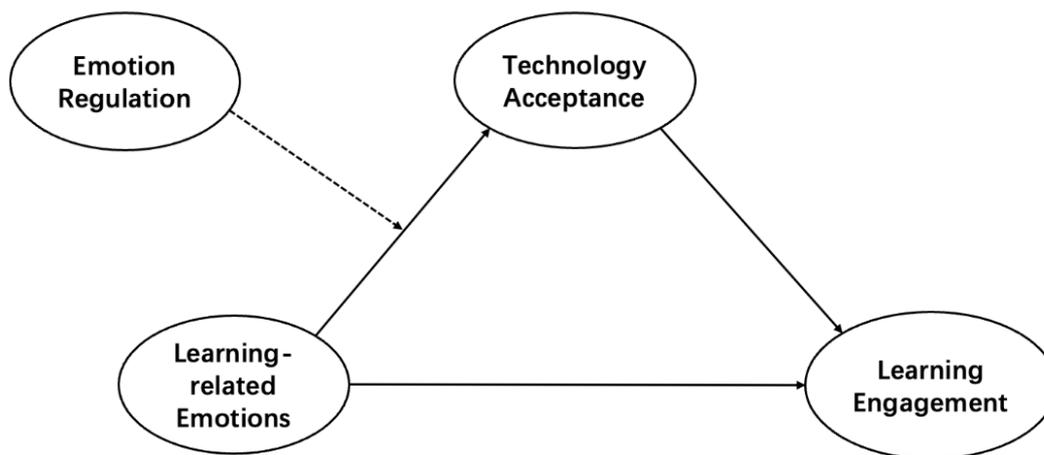


Figure 1. Simplified conceptual model highlighting the key concepts of this study

## Research methods

### Instruments

We collected data using a questionnaire comprising two parts: (a) basic information on the survey participants and (b) measures for the conceptual model of this study. The first part collected the survey participants' gender, age, educational background, university type, frequency and duration of the online PD programmes they attended as well as the learning platforms used. In the second part, we created our survey by referencing four established questionnaires while making appropriate adaptations for the online PD context (e.g., "I listen carefully in class" was modified to "I listen carefully in online professional development learning sessions"). The second part of the questionnaire consisted of four measures. For learning-related emotions, we chose the Bieleke et al.'s (2021) short version of the Achievement Emotions Questionnaire. Within this scale, the subscale of positive learning-related emotions consists of enjoyment, hope and pride; the subscale of negative learning-related emotions consists of anger, anxiety, shame, hopelessness and boredom. For technology acceptance, we used Dečman (2015)'s questionnaire, which consists of five subscales: performance expectancy, effort expectancy, social influence, facilitating conditions and behavioural intention. For learning engagement, we used Reeve and Tseng's (2011) questionnaire, which is composed of four subscales: behavioural, emotional, cognitive and agentic engagement. Finally, we used Gross and John's (2003) Emotion Regulation Questionnaire, which is made up of two subscales: reappraisal and suppression. Each item in the second part of the questionnaire was measured on a Likert scale. Items of the Learning-related Emotions scale were measured using the 5-point

Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*); all other items were measured using the 7-point Likert scale, with scores ranging from 1 (*strongly disagree*) to 7 (*strongly agree*).

Before distributing the questionnaire, we completed the following tasks. First, we applied the translation and back-translation technique (Tsang et al., 2017) to convert the English questionnaire into a Chinese-English bilingual format. Two English major graduate students who are native Chinese speakers independently translated the questionnaire from English to Chinese and compared their translations before finalising the Chinese version. After that, two Chinese-and-English speaking researchers conducted the back-translation (i.e., from Chinese to English) to check for accuracy of the previous translation. Then, we invited three Chinese-and-English speaking colleagues to review the bilingual questionnaire to verify the questionnaire's content accuracy, reliability and validity. Finally, we performed a pre-test to examine the Cronbach's alpha values and exploratory factor analysis results of the four measures in the second part of our bilingual questionnaire. Our pre-test results confirmed our questionnaire's reliability and validity.

### Setting and participants

Ethical approval was obtained from X. L.'s university prior to sending out the survey (Ethical approval code: ER-AOFE-0010000080120221030213130).

The survey was distributed in December 2022 in a south-eastern province of China. Post-pandemic, the Chinese Ministry of Education issued an online education policy, urging all universities to provide only online courses (Gu et al., 2022). HE institutions in China have widely adopted the online PD mode (Y. Yin et al., 2022), including the investigated province. The survey was distributed via a popular mobile platform, Wenjuanxin, ensuring a wide reach of faculty from different universities in the province. A convenience sampling strategy was adopted for data administration (Cohen et al., 2017). A total of 265 HE faculty completed the online survey. Questionnaires without consent were excluded, resulting in 254 valid surveys. Response patterns and survey completion time were checked to ensure response validity. Finally, 254 surveys were used for analysis, making the valid response rate 95.89%. Based on the demographic information provided by the valid participants, 106 were males and 146 were females (two respondents chose not to reveal their gender). A total of 87 faculty were from private universities and 167 from public universities. Of the respondents, 40.16% held a doctoral degree, 49.60% held a master's degree and 10.24% held a bachelor's degree as their highest qualification. Over 33% of the participating HE faculty had fewer than 5 years of teaching experience, while 30% had over 15 years of teaching experience. During online PD, 132 faculty (slightly over half of the sample target) used their institution's online platform, while 122 used public learning platforms such as massive open online courses.

### Data analysis

This study adopted the partial least squares structural equation model (PLS-SEM) for analysis, using SmartPLS version 3.3.9, for three key reasons. First, when the research objective is a prediction rather than a confirmation, the variance-based PLS-SEM is the preferred method (Hair et al., 2011b). Second, PLS-SEM can overcome the empirical research obstacle of small sample sizes (Hair et al., 2011b). Third, PLS-SEM does not presume that the data are normally distributed (Hair et al., 2011b). Since the survey questionnaires included multiple measurement indicators, a parcelling strategy was used during data analysis to obtain the mean value of the measurement indicators belonging to the same subscale (Yang et al., 2009). Y. Wu and Wen (2011) confirmed that parcelling can promote better indicator quality and model fit if the parcelled items feature one-dimensionality and homogeneity.

## Results

### Common method bias

According to Podsakoff et al. (2003), data obtained from questionnaires can result in common method bias and explained variance for the first factor should be below 40%. To check for this bias, Harman's single factor test was used on IBM SPSS version 25.0 and a value of 24.822% was obtained. This indicates that common method bias did not significantly affect the results of this study (S. Wang et al., 2021). Latent common method factor analysis was also employed to examine common method bias. The ratio of R1 square to R2 square in Table 1 is 79.625, indicating that common method bias was not a serious issue (Liang et al., 2007).

Table 1

*Common method bias analysis*

Item	Standard factor loading (R1)	R1 square	Common method factor R2	R2 square
Anger	0.774	0.599	-0.169	0.029
Anxiety	0.774	0.599	0.072	0.005
Behavioural intention	0.78	0.608	0.093	0.009
Boredom	0.773	0.598	0.119	0.014
Effort expectancy	0.784	0.615	0.046	0.002
Reappraisal	0.888	0.789	0.07	0.005
Suppression	0.879	0.773	-0.073	0.005
Enjoyment	0.813	0.661	0.181	0.033
Facilitating conditions	0.781	0.61	-0.147	0.022
Hope	0.822	0.676	-0.063	0.004
Hopeless	0.785	0.616	0.041	0.002
Behavioural engagement	0.79	0.624	0.007	0
Agentic engagement	0.791	0.626	-0.016	0
Cognitive engagement	0.793	0.629	0.027	0.001
Emotional engagement	0.793	0.629	-0.018	0
Performance expectancy	0.764	0.584	-0.024	0.001
Pride	0.824	0.679	-0.121	0.015
Social influence	0.771	0.594	0.028	0.001
Shame	0.769	0.591	-0.06	0.004
Average		0.637		0.008
Ratio: R1 square/R2 square				79.625

### Assessment of measuring instrument

We examined the reliability and validity of the measurement model. According to Hair et al. (2011a), in PLS-SEM, the reliability should be tested through outer loadings, Cronbach alpha and composite reliability (CR), the threshold values of which should all exceed 0.7 to ensure indicator reliability and internal consistency among the items of measure scale; validity was assessed through convergent and discriminant validity. Convergence of item scale in each construct was assessed by average variance extracted (AVE), with a cut-off point of 0.5; discriminant validity was tested by Fornell-Larcker criterion and heterotrait-monotrait ratio (HTMT) (Hair et al., 2011a). Our results (Table 2) conform to the above rules for reliability and convergent validity, with Cronbach's alpha scores ranging from 0.719 to 0.835, CR scores being larger than 0.85 and AVE ranging from 0.599 to 0.777. Furthermore, the item outer loadings of the measure model should be higher than 0.7 (Hulland, 1999). In our measurement model, the results show that the outer loadings of all items were above 0.759. These results demonstrate that the measures have good reliability and convergent validity.

Table 2  
Cronbach’s alpha, CR, and AVE for the measures

Item	Cronbach’s alpha	rho_A	CR	AVE
ER	0.719	0.770	0.874	0.777
LE	0.801	0.802	0.870	0.627
NE	0.834	0.843	0.882	0.599
PE	0.755	0.764	0.859	0.670
TA	0.835	0.836	0.883	0.602

Note. ER: emotion regulation; LE: learning engagement; NE: negative learning-related emotions; PE: positive learning-related emotions; TA: technology acceptance

Table 3 shows the results of applying the Fornell-Larcker criterion, demonstrating that the correlation coefficient between each latent variable and other latent variables was smaller than the square root of the AVE of the latent variables. Table 4 shows the results of HTMT, with all values lower than the threshold value of 0.85 (Henseler et al., 2015). These results demonstrate the discriminant validity of the measurement model. Based on Tables 2–4, our instrument shows good reliability and validity.

Table 3  
Fornell-Larcker criteria

Item	ER	LE	NE	PE	TA
ER	0.881				
LE	0.153	0.792			
NE	-0.103	-0.122	0.774		
PE	0.243	0.379	-0.306	0.819	
TA	0.311	0.430	-0.466	0.489	0.776

Note. ER: emotion regulation; LE: learning engagement; NE: negative learning-related emotions; PE: positive learning-related emotions; TA: technology acceptance

Table 4  
HTMT

	ER	ER*NE	ER*PE	LE	NE	PE	TA
ER							
ER*NE	0.231						
ER*PE	0.329	0.034					
LE	0.19	0.125	0.156				
NE	0.133	0.042	0.111	0.146			
PE	0.305	0.128	0.261	0.486	0.359		
TA	0.389	0.194	0.122	0.526	0.55	0.605	

Note. ER: emotion regulation; NE: negative learning-related emotions; PE: positive learning-related emotions; LE: learning engagement; TA: technology acceptance

### Hypothesis testing

The bootstrapping method ( $n = 5000$  bootstrap samples) was used to examine the statistical significance of the path coefficients among the variables and the moderating and mediating effects. The results are shown in Figures 2, 3 and 4, as well as Tables 5, 6 and 7. The results show that all hypotheses other than H4 (HE faculty’s negative learning-related emotions negatively impact their online learning engagement in online PD) were supported. As Figure 2 shows, the R square values of the two dependent variables, namely technology acceptance and learning engagement, are 0.445 and 0.234. According to Figure 2 and Table 5, in online PD, faculty’s positive emotions positively impact their technology acceptance ( $\beta = 0.414, p < 0.001; H1$ ), whereas their negative emotions have a negative impact on technology acceptance ( $\beta = -0.292, p < 0.001; H2$ ). H3 was also supported, showing that HE faculty’s positive learning-related emotions positively impacted their learning engagement ( $\beta = 0.234, p < 0.05$ ). Online learning engagement was positively predicted by their technology acceptance ( $\beta = 0.373, p < 0.01; H5$ ).

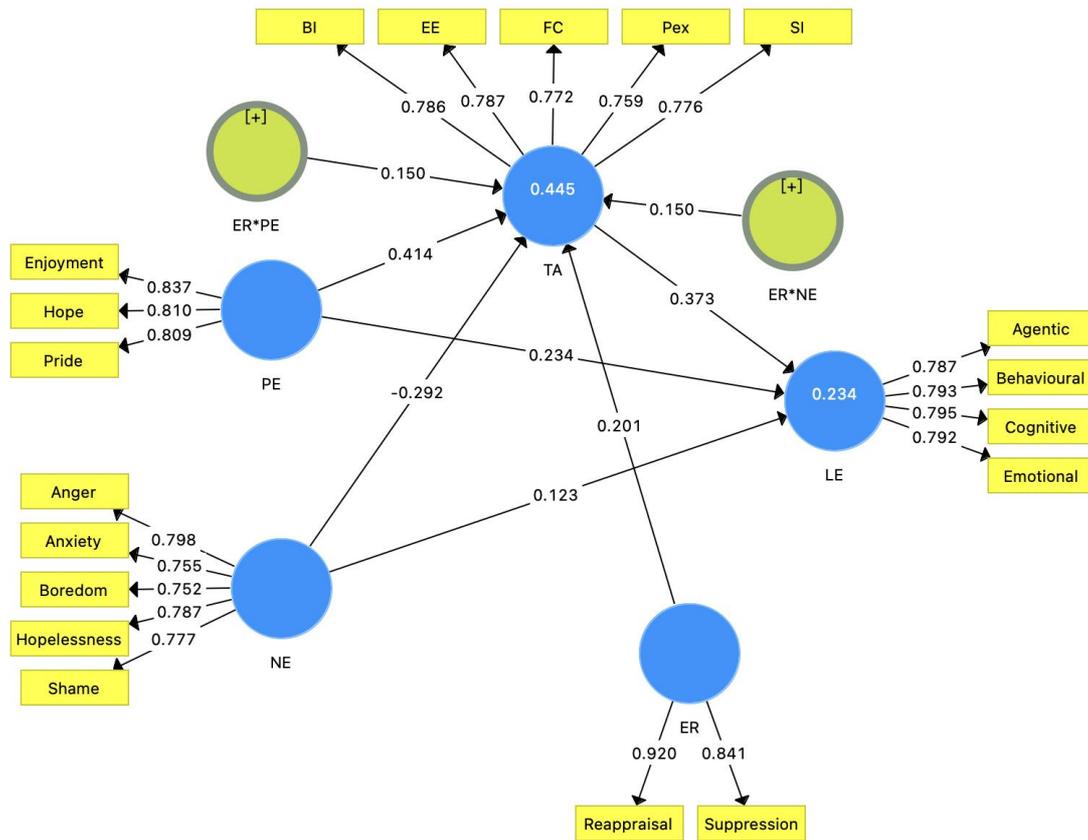


Figure 2. Structural equation model of the PLS results

Note. BI: behavioural intention; EE: effort expectancy; FC: facilitating conditions; Pex: performance expectancy; SI: social influence

Table 5  
Path coefficients among the latent variables

Hypothesis	Path	Original sample (O)	Sample mean (M)	SD	T statistics ( O/SD )	P values	Results
H1	PE → TA	0.414***	0.418	0.077	5.399	0	Supported
H2	NE → TA	-0.292***	-0.294	0.062	4.7	0	Supported
H3	PE → LE	0.234*	0.236	0.114	2.052	0.04	Supported
H4	NE → LE	0.123	0.116	0.079	1.566	0.117	Not supported
H5	TA → LE	0.373**	0.367	0.124	3.003	0.003	Supported

Note. PE: positive learning-related emotions; TA: technology acceptance; NE: negative learning-related emotions; LE: learning engagement

\* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

Mediating effects of technology acceptance

Figure 2 and Table 6 show that the mediating role of technology acceptance in the relations between the participants' learning-related emotions, both positive and negative, and online learning engagement in online PD was supported (H6 and H7). The faculty's positive emotions positively impacted their technology acceptance, thereby leading to higher online learning engagement. Their negative emotions indirectly affected online learning engagement, with technology acceptance as the mediator.

Table 6  
*Mediating effects of technology acceptance*

Hypothesis	Path	Original sample (O)	Sample mean (M)	SD	T statistics ( O/SD )	P values	Results
H6	PE -> TA -> LE	0.154*	0.154	0.061	2.542	0.011	Supported
H7	NE -> TA -> LE	-0.109**	-0.107	0.042	2.627	0.009	Supported

Note. PE: positive learning-related emotions; TA: technology acceptance; LE: learning engagement; NE: negative learning-related emotions

\* $p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

*Moderating effects of emotion regulation*

Figure 2, Table 7 and Figures 3 and 4 show the moderating role of emotion regulation in the relation between learning-related emotions and technology acceptance. The participants' emotion regulation moderated the relationship between positive learning-related emotions and technology acceptance (H8) and between negative emotions and technology acceptance (H9). Specifically, Figure 3 demonstrates that emotion regulation can enhance the positive impact of positive learning-related emotions on technology acceptance. Moreover, with a higher level of emotion regulation, the same level of positive emotions can result in higher technology acceptance. Figure 4 shows that emotion regulation can reduce the negative impact of negative learning-related emotions on technology acceptance. When emotion regulation is higher, the same level of negative emotions can result in higher technology acceptance.

Table 7  
*Moderating role of emotion regulation*

Hypothesis	Path	Original sample (O)	Sample mean (M)	SD	T statistics ( O/SD )	P values	Results
H8	ER*PE -> TA	0.15*	0.146	0.061	2.454	0.014	Supported
H9	ER*NE -> TA	0.15*	0.151	0.06	2.488	0.013	Supported

Note. ER: emotion regulation; PE: positive learning-related emotions; TA: technology acceptance; NE: negative learning-related emotions

$p < 0.05$ . \*\* $p < 0.01$ . \*\*\* $p < 0.001$ .

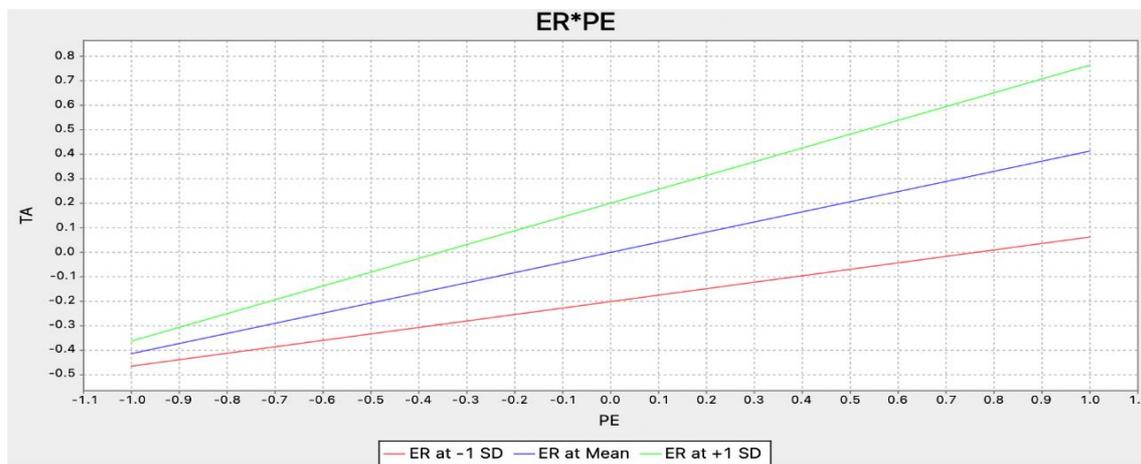


Figure 3. Simple slope analysis: the moderating effect of emotion regulation on the relationship between positive learning-related emotions and technology acceptance

Note. ER: emotion regulation; PE: positive learning-related emotions; TA: technology acceptance

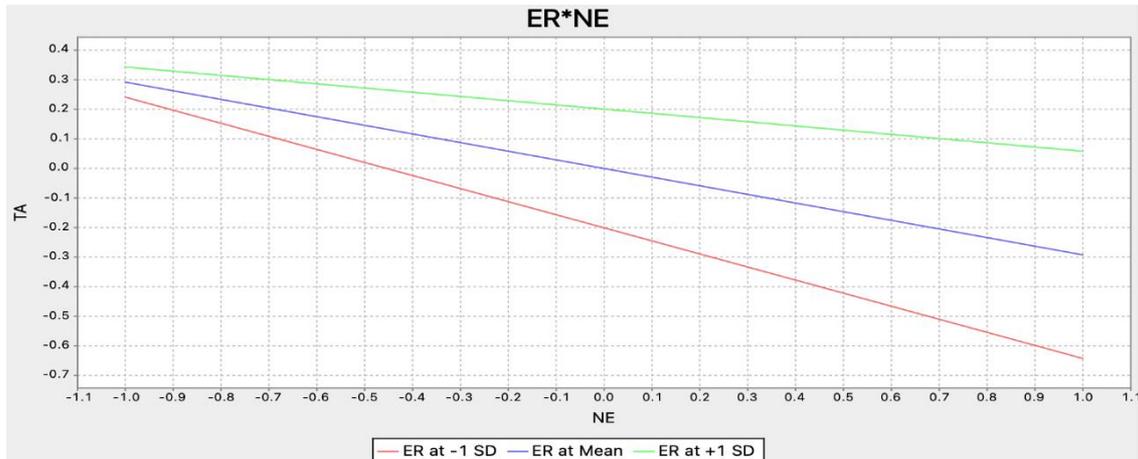


Figure 4. Simple slope analysis: the moderating effect of emotion regulation on the relationship between negative learning-related emotions and technology acceptance

Note. ER: emotion regulation; NE: negative learning-related emotions; TA: technology acceptance

## Discussion

### Validation of previous studies in the context of faculty's online PD

First, the findings confirm that HE faculty's positive learning-related emotions predict higher technology acceptance and that negative learning-related emotions predict lower technology acceptance, which aligns with literature in non-PD online learning contexts (e.g., Chea & Luo, 2019; C. Wu et al., 2021). Learners' positive emotions (e.g., enjoyment) are positively associated with behavioural intentions regarding technology acceptance (C. Wu et al., 2021). Positive learning-related emotions reinforce learners' belief that using technology will be easy (effort expectancy) and can enhance their performance (performance expectancy). In contrast, online learners' negative learning-related emotions negatively predict technology acceptance by decreasing their effort and performance expectancy levels.

Second, faculty with positive learning-related emotions demonstrate higher levels of learning engagement in their online PD. This finding accords with research in online academic settings among university students (D'Errico et al., 2016; Y. Wang et al., 2022). Scholars have suggested that learners with positive learning-related emotions can proactively access learning resources and show higher self-regulation during learning, which makes them more engaged (Pekrun et al., 2011, Zhen et al., 2017). When faculty show more positive learning-related emotions, they are likely to devote more effort to acquiring resources in the online environment, show greater persistence and consequently display higher learning engagement in online PD.

Third, the findings indicate that faculty's technology acceptance positively predicts learning engagement in online PD. This finding validates the role of learners' technology acceptance in online settings, reinforcing other research (e.g., Jung & Lee, 2018; Kala & Chaubey, 2022). Learners' positive attitudes towards online learning technology can be a powerful tool for promoting online interactions, communication and engagement (Ustun et al., 2021). When learners believe that technology can help them perform better, their higher acceptance of using technology can promote their engagement in online learning (Jung & Lee, 2018).

### New evidence for the role of negative learning-related emotions

Regarding the relation between negative learning emotions and online learning engagement (e.g., Artino & Jones, 2012; C. Wu et al., 2021), our findings suggest that negative learning-related emotions as a cluster are not associated with learning engagement in online PD. A possible explanation is that faculty's perceptions of their negative emotional experiences are influenced by their agency (Hökkä et al., 2017).

Alternatively, the impact of negative emotions on online learning engagement could depend on the specific negative emotion and its intensity. For instance, low to medium levels of anxiety can negatively affect learners' engagement, while medium to high levels of anxiety may be positively related to engagement (Abu-Hilal & Al Abed, 2019).

### **Moderating role of HE faculty's emotion regulation**

It appears no study has examined the moderating effect of emotion regulation on the relation between learning-related emotions and technology acceptance. This study found that faculty's emotion regulation acts as a moderator, which can enhance the positive impact of positive learning-related emotions and reduce the negative impact of negative learning-related emotions on technology acceptance. When faculty show a high capacity for emotion regulation, regardless of whether the learning-related emotions are positive or negative, emotion regulation will influence the relationship to arrive at greater acceptance of technology. The essence of enhancing learners' technology acceptance is to positively shape users' perceptions of learning technology in terms of its usefulness and ease of use (Venkatesh et al., 2003). Emotion regulation can help individuals exert control over unfamiliar technology-related situations and maintain optimism, thus resulting in positive attitudes towards technology adoption and technology-related changes (Beaudry & Pinsonneault, 2005).

### **Mediating role of HE faculty's technology acceptance**

In this study, the direct relation between faculty's negative learning-related emotions and online learning engagement was not supported. However, when technology acceptance was introduced into that relationship, negative learning-related emotions negatively affected technology acceptance, thereby affecting online learning engagement. This finding reinforces the mediating role of technology acceptance, which was also found between positive learning-related emotions and online learning engagement. When faculty show more positive learning-related emotions, they have higher technology acceptance, resulting in greater online learning engagement. This statistical evidence highlights a distinctive feature of online learning, which is learners' use and acceptance of technology (Kidd & Keengwe, 2009). When learners' learning-related emotions adversely impact their acceptance of technology, it ultimately reduces their online learning engagement. Therefore, understanding the factors impacting technology acceptance and maintaining a high level of technology acceptance are of great value in faculty's online PD.

### **Practical implications**

This study affirms the importance of attending to faculty's positive emotions in online PD (Gu et al., 2022). In alignment with Pekrun's (2006) control-value theory, faculty will generate more positive learning-related emotions when they find value and/or perceive that they have control over online PD activities and learning outcomes. Hence, the current study suggests that PD should provide a variety of content for faculty to choose according to their career needs. The PD designer should consider faculty's learning needs when creating learning activities (Wynants & Dennis, 2018). PD instructors should foster an encouraging and supportive environment for faculty to build confidence in their learning. Instructors should also look for content that can be usefully applied to faculty's teaching practices (Gaines et al., 2019). These endeavours can enhance faculty's positive learning-related emotions in online PD.

Another implication is that enhancing faculty's technology acceptance will lead to higher learning engagement in online PD. Many strategies and measures have been based on the Venkatesh et al.'s (2003) unified theory of acceptance and use of technology model to promote technology acceptance (e.g. Gibson et al., 2008; Ustun et al., 2021). Our study suggests PD personnel have an important role in enhancing users' technology acceptance. HE institutions should develop policies to nurture inclusive and supportive online PD cultures across campuses (Ustun et al., 2021), treating online PD initiatives as university-wide collaborative efforts. PD designers should include pre-session courses to introduce the value, usefulness

and ease of using the technology in online PD. PD instructors should demonstrate how to use specific online platforms or applications before engaging in the PD itself.

The findings also point to the importance of faculty's emotion regulation in online PD. Research has emphasised the critical role of educators' emotion regulation abilities for a successful professional life (H. Yin et al., 2016). PD instructors could provide emotional support, such as offering mentorship or introducing role models, to help HE faculty to improve their emotion regulation practices in online learning (He et al., 2023; Nyanjom & Naylor, 2020). PD designers could purposively launch training courses, such as how to appropriately use emotion regulation strategies to reappraise emotion-elicited issues (Jiang et al., 2016) or suppress and mitigate undesirable emotions (Akbari et al., 2017). These strategies can enable faculty to reach a higher level of technology acceptance even when they experience negative learning-related emotions in online PD and thus gain more benefit from online PD.

### Limitations and future research

We acknowledge several limitations. First, the data come from HE institutions in a particular region of China. More empirical studies in other demographic locations are needed to validate the proposed model. Second, we did not investigate the specific sub-categories of learning-related emotions and emotion regulation strategies. Future research could build upon this study's findings to explore the specific impact of each learning-related emotion in faculty's online PD settings and the impact of each emotion regulation strategy on learning emotions and technology acceptance. The third limitation is that although participants all participated in PD online, the research did not account for the potential influence of different course delivery settings and designs. Future studies could examine faculty who participate in the same and different PD courses. Lastly, this study is based on data collected at a single point in time, reflecting its correlational nature. Conducting longitudinal research would enhance the ability to establish causality and track changes in learners' emotions, technology acceptance and learning engagement.

### Author contributions

**Author 1:** Investigation, Data curation, Formal analysis, Writing – original draft; **Author 2:** Conceptualisation, Formal analysis, Supervision, Writing – review and editing; **Author 3:** Supervision, Writing – review and editing; **Author 4:** Writing – review and editing; **Author 5:** Supervision, Methodology, Writing – review and editing; **Author 6:** Conceptualisation, Data curation, Supervision, Writing – review and editing.

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