University teachers' well-being in ICT-enhanced teaching: The roles of teacher self-efficacy and teaching support

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In the context of information and communication technology (ICT)-enhanced teaching, teacher well-being plays a crucial role in promoting teaching effectiveness and students' learning achievement. Drawing on the interactionist model of teacher well-being, this study investigated university teachers' well-being (e.g., emotional exhaustion and teacher engagement) in ICT-enhanced teaching and its associations with their self-efficacy (e.g., classroom management, instructional strategy and course design) and teaching support (e.g., autonomy support, teaching resources and peer support). The results of an online questionnaire survey conducted among 836 university teachers in China indicated that the enhanced integration of ICT into teaching practices neither impaired teacher engagement nor caused them significant emotional exhaustion. Instead, adequate teaching resources and autonomy support contributed positively to both teacher self-efficacy and engagement. Increased efficacy in course design and classroom management alleviated their emotional exhaustion. Moreover, teacher self-efficacy significantly mediated the effects of autonomy support on emotional exhaustion and teacher engagement. These results have practical implications for understanding and promoting university teachers' well-being as well as teaching effectiveness in ICT-enhanced teaching environments.

Implications for practice or policy
- Administrators may consider providing adequate resources geared towards enhancing university teachers' confidence and engagement in ICT-enhanced teaching.
- Administrators may avoid introducing excessive and burdensome initiatives to university teachers to prevent teacher emotional exhaustion.
- University teachers may be granted significant autonomy in selecting their preferred teaching platforms, methods and materials to meet their specific needs and preferences in ICT-enhanced teaching.

Keywords: university teacher well-being, teacher self-efficacy, teaching support, information and communication technology, ICT-enhanced teaching

Introduction

Information and communication technology (ICT) has been widely adopted by higher education institutions worldwide as a catalyst for enhancing knowledge acquisition, productivity and education quality (Fahadi & Khan, 2022; Moreira-Fontán et al., 2019; Schettino et al., 2022). Through its integration into educational practices with various technologies, ICT has rapidly transformed the delivery of courses and brought about significant changes to both student learning and teacher instruction (Bedenlier et al., 2020; Chen et al., 2022; Zhang et al., 2023). These technologies can be applied in traditional face-to-face classrooms, blended teaching or online teaching (Khalid et al., 2023; Khan & Markauskaite, 2017). It is worth noting that the widespread pandemic not only intensified ICT application in online teaching and learning processes but also had a profound impact on teachers' attitudes towards teaching (Ahmed, 2021; Khalid et al., 2023; Zhao & Song, 2021). Research has demonstrated that technology alone is insufficient for promoting student learning (Khan, 2015), and the effectiveness of technology in facilitating students' learning processes and outcomes is largely dependent on teachers' understanding and attitudes towards

ICT (Albirini, 2006; Khalid et al., 2023). Therefore, the more supportive and positive teachers are towards ICT, the greater their willingness to integrate enhanced technology and implement changes in their courses (Bibi & Khan, 2016; Tondeur et al., 2019). Several studies have suggested that factors such as inadequate preparation (Fahadi & Khan, 2022), insufficient training and support (Joo et al., 2016) and a lack of infrastructure (e.g., Internet access) (Ahmed, 2021), have resulted in anxiety, resistance and technostress among teachers (Fahadi & Khan, 2022; Joo et al., 2016), hindering their adoption of ICT in teaching practices. Despite the acknowledged benefits of ICT integration, researchers maintain a sceptical stance on its potential to enhance positive aspects and mitigate negative ones among teachers (Bhat & Beri, 2016). Thus far, scant attention has been given to the positive emotions experienced by teachers in ICT-enhanced teaching (Moreira-Fontán et al., 2019).

Studies have suggested that of various emotions, well-being is closely related to digital technologies and artificial intelligence (Moreira-Fontán et al., 2019; Passey, 2021). In the academic field, teacher well-being has emerged as a research trend (De Pablos-Pons et al., 2013), which reflects teachers' affective experiences and evaluations of their teaching experiences (Collie et al., 2015). Although a consensus definition of teacher well-being has yet to be formulated, it is widely recognised as a multidimensional construct (Aadmi-Laamech et al., 2022), encompassing both positive and negative dimensions (Bakker & Oerlemans, 2011; Han et al., 2020; Skaalvik & Skaalvik, 2014; Ventura et al., 2015). Research has emphasised the crucial role of teacher well-being in the professional development of individual teachers, instructional quality, organisational commitment and teaching effectiveness (Collie et al., 2015; De Pablos-Pons et al., 2013; Hascher & Waber, 2021; Huang & Yin, 2018). Therefore, it is imperative to explore strategies that can enhance teacher well-being (Hascher & Waber, 2021).

Of various theoretical models aiming at explaining and promoting teacher well-being, the interactionist model posits that individual and contextual factors jointly contribute to teacher well-being (De Pablos-Pons et al., 2013), as supported by subsequent research (e.g., Huang & Yin, 2018). Given the increasing changes and challenges brought about by ICT integration in teaching practices, researchers have emphasised potential links between teacher well-being and ICT-related variables (Hascher & Waber, 2021; Moreira-Fontán et al., 2019). However, there is a dearth of knowledge on the factors that impact teacher well-being in ICT-enhanced teaching, particularly in relation to online teaching caused by the pandemic. To address this research gap and identify effective strategies for promoting teacher well-being, this study aimed to investigate the well-being of university teachers in an ICT-enhanced online teaching context and explore its relationship with individual and contextual factors (e.g., self-efficacy and support) identified through the interactionist model of teacher well-being.

Literature review

Teacher well-being

The issue of well-being has attracted considerable interest from diverse academic fields (Aadmi-Laamech et al., 2022), with its significance underscored since the 1940s (Hascher & Waber, 2021). Despite the lack of a universally accepted conceptualisation, well-being is widely perceived as a multidimensional construct (Aadmi-Laamech et al., 2022; Hascher & Waber, 2021). Within the realm of education, research on teacher well-being emerged in the early 1990s (De Pablos-Pons et al., 2013) and has experienced rapid and significant development over the past decade (Huang & Yin, 2018). In general, teacher well-being encompasses teachers' favourable evaluations and healthy functioning within the environments where they work (Hascher & Waber, 2021).

Expanding on Bakker and Oerlemans' (2011) proposal that well-being encompasses both positive affective states (e.g., work engagement, job satisfaction and happiness at work) and negative affects (e.g., burnout and workaholism), empirical research has examined its dual aspects (Han et al., 2020; Skaalvik & Skaalvik, 2014; Ventura et al., 2015), utilising emotional exhaustion and teacher engagement as primary indicators (Han et al., 2020). Emotional exhaustion, the primary characteristic of burnout, refers to the state of experiencing mental and physical fatigue, accompanied by depletion of emotional and physical resources

(Maslach et al., 1997). Conversely, work engagement was initially defined as the direct opposite of individuals' experience on a continuum from burnout (Maslach et al., 1997). With the advancements in positive psychology since the turn of the 21st century, Schaufeli et al. (2006) suggested that engagement be defined as a positive and fulfilled work-related state of mind marked by vigour, dedication and absorption. As such, it serves as a positive indicator of well-being that is frequently examined in empirical research (Han et al., 2020). Drawing on research, we selected emotional exhaustion and teacher engagement as focal variables of teacher well-being due to the aim of this study being an investigation into the well-being of Chinese university teachers, similar to Han et al. (2020).

Given the demanding and stressful responsibilities that come with teaching (Han et al., 2020), teacher well-being is significant for ensuring high-quality teaching, fostering teacher commitment and promoting positive student learning outcomes (Collie et al., 2015; Huang & Yin, 2018). As a result, there has been growing interest among researchers and educators in exploring factors that promote teacher well-being (Collie et al., 2015). The study conducted by De Pablos-Pons et al. (2013) summarised three theoretical models to elucidate teacher well-being: the contextual variable model, the psychological model and the interactionist model. Specifically, the contextual model focuses on variables associated with various contexts, highlighting that teacher well-being is predominantly influenced by external factors such as cultural norms and educational environments. In contrast, the psychological model emphasises individual characteristics, including teaching competencies, personality and control of life, as primary contributors to the development of teacher well-being. Though both the two theoretical models have generated a substantial body of empirical research (De Pablos-Pons et al., 2013), they solely focus on a singular aspect of the multifaceted factors that contribute to teacher well-being. The interactionist model, which integrates the aforementioned two models, offers a comprehensive interpretation of teacher well-being by synergistically considering the combination of individual and contextual elements that foster teacher well-being. Nevertheless, the interactionist model has not received sufficient scholarly attention (De Pablos-Pons et al., 2013) and requires further in-depth evidence to support its validity.

A systematic review of 98 studies on teacher well-being has identified work-related key factors that contribute to teacher well-being, including work-related individual factors, like feelings of competence or efficacy and work-related contextual factors, such as collegial support, support for autonomy and supportive work environment (Hascher & Waber, 2021). However, in the context of ICT-related research on teachers, there has been a predominant focus on examining the impact of ICT on instructional practices and student learning outcomes (Chen et al., 2022; Passey, 2021; Wu et al., 2021). Limited understanding exists regarding the complex interplay of individual and contextual factors concerning the multidimensional nature of teacher well-being in ICT-enhanced teaching, particularly within the online teaching context necessitated by the pandemic. Therefore, building upon reviews as well as explanatory models of teacher well-being, this study attempted to explore the relationships between teacher well-being and teacher self-efficacy (as an individual factor) as well as teaching support (as a contextual factor) in ICT-enhanced teaching.

Teacher self-efficacy in ICT-enhanced teaching

Self-efficacy, derived from Bandura's (1997) social cognitive theory, refers to individuals' belief in their ability to organise and execute courses of action to perform particular tasks. It provides an effective theoretical framework for explaining human behaviours, thoughts and emotions in a variety of contexts, such as education, sports and business (Hampton et al., 2020). Within the educational context, teacher self-efficacy is defined as teachers' judgements of their capabilities to influence their students' engagement and learning (Chang et al., 2011).

As teacher self-efficacy is context-specific (Han et al., 2018), teachers judge their teaching competence based on a number of contextual factors, such as constraints and resources (Tschannen-Moran & Hoy, 2007). Inspired by research on the teacher self-efficacy of primary and secondary school teachers, Chang et al. (2011) developed a comprehensive measure to assess university teachers' self-efficacy across six dimensions: course design, classroom management, instructional strategy, interpersonal relations, learning assessment and technology use. This measure has been validated through research conducted

with Chinese university teachers and exhibits robust psychometric features in both traditional face-to-face classrooms (Han et al., 2020) and ICT-enhanced online teaching settings (Han et al., 2021). Specifically, the prioritisation of teachers' confidence in course design, instructional strategy and classroom management was found to be crucial for their self-efficacy in ICT-enhanced teaching during the outbreak of the pandemic (Han et al., 2021). Therefore, we selected these three dimensions of teacher self-efficacy for investigation in the present study.

A review of research indicates that teacher self-efficacy has strong associations with learning and teaching outcomes, such as students' academic achievement, teaching effectiveness, teacher commitment and teacher and student well-being (Hampton et al., 2020; Huang & Yin, 2018; Tondeur et al., 2019). Research on the relationships between teacher self-efficacy and well-being has revealed that teacher self-efficacy is a powerful predictor of emotional exhaustion and teacher engagement (Huang & Yin, 2018; Skaalvik & Skaalvik, 2014). As teachers with high levels of self-efficacy tend to feel optimistic about their performance and personal accomplishments, they are likely to be persistent in, dedicated to and highly engaged with their teaching. In contrast, teachers with low confidence in their teaching tend to have pessimistic feelings associated with depression, anxiety and burnout (Ventura et al., 2015). However, despite the robust association between teachers' self-efficacy in technology utilisation and their inclination towards active engagement in technology-integrated instructional practices, further empirical evidence is necessary to substantiate this claim within the context of ICT-enhanced teaching (Scherer & Siddiq, 2015; Tondeur et al., 2019; Zhang et al., 2023).

Teaching support in ICT-enhanced teaching

Teaching support is a significant contributor to teaching and learning outcomes (Han et al., 2018; Moreira-Fontán et al., 2019). Scholars have conceptualised teaching support in different dimensions. For example, Tschannen-Moran and Hoy (2007) identified five areas of perceived teaching support for primary and secondary school teachers: teaching resources, interpersonal support provided by administrative staff, interpersonal support provided by colleagues, parental support and involvement with classroom activities and community support. Similarly, university teachers mainly derive support from their access to teaching resources and from peers and administrators (Chang et al., 2011). This finding is further reinforced by a recent study conducted by Han et al. (2021), which unveiled that teaching support, in terms of teaching resources, peer support and autonomy support, is associated with innovative teaching and job satisfaction among university teachers in ICT-enhanced teaching caused by the pandemic. The prioritisation of comprehensive institutional support for ICT-enhanced teaching encompasses both internal and external resources and increased teacher autonomy in course implementation (Moreira-Fontán et al., 2019; Zhao & Song, 2021). Meanwhile, teachers require increased flexibility over teaching implementation, such as having greater control of their classes and making decisions regarding communication synchrony and student assessment (Iglesias-Pradas et al., 2021). Therefore, autonomy support, which represents teachers' subjective sense of control over their teaching activities (Inigo & Raufaste, 2019), is a vital form of support that is provided by the administrators (Peach & Bieber, 2015). Based on the literature, we selected teaching resources, peer support and autonomy support as indicators of teaching support in ICT-enhanced teaching.

Studies have suggested that teaching support is closely related to teacher self-efficacy in different teaching environments (Hampton et al., 2020; Richter & Schuessler, 2019). According to Bandura's (1997) self-efficacy theory, teachers' performance is reciprocally associated with their perceptions of specific teaching contexts. Therefore, university teachers' perceived teacher self-efficacy is partly based on several contextual factors, such as the availability of resources and the degree of constraints (Tschannen-Moran & Hoy, 2007). Additionally, support from peers, in the form of verbal persuasion (Bandura, 1997), may make a difference in university teachers' perceptions of their teacher self-efficacy (Richter & Schuessler, 2019). Moreover, as highlighted by Hascher and Waber (2021), there is consistent evidence linking teacher well-being to a supportive working environment which includes collegial support, leader support and autonomy support. Specifically, insufficient job resources (e.g., teaching resources, autonomy and peer support) as well as low efficacy (Han et al., 2020) can decrease teacher engagement and increase emotional exhaustion levels. Additionally, teacher self-efficacy serves as a mediator in the

relationships between work-related factors and teacher well-being (Bakker & Demerouti, 2017; Han et al., 2020). Although there is extensive knowledge on the impact of ICT on instructional practices and student learning outcomes (Chen et al., 2022; Passey, 2021; Wu et al., 2021), few studies have examined the intricate interplay of individual and contextual factors for university teachers' well-being in ICT-enhanced teaching, particularly online teaching during the pandemic in non-Western contexts.

Therefore, building upon previous reviews as well as explanatory models of teacher well-being, this study developed a theoretical framework (see Figure 1) to explore university teachers' well-being and its relationships with teacher self-efficacy and teaching support, focusing on the ICT-enhanced online environment during the pandemic. It also examined the mediating role of teacher self-efficacy in the relationships between teaching support and teacher well-being. Specifically, the following three questions were addressed in this study:

(1) What are the characteristics of university teachers' well-being in ICT-enhanced teaching?
(2) What are the relationships between university teachers' teaching support, teacher self-efficacy and teacher well-being in ICT-enhanced teaching?
(3) Does teacher self-efficacy serve as a mediator between teaching support and teacher well-being in ICT-enhanced teaching?
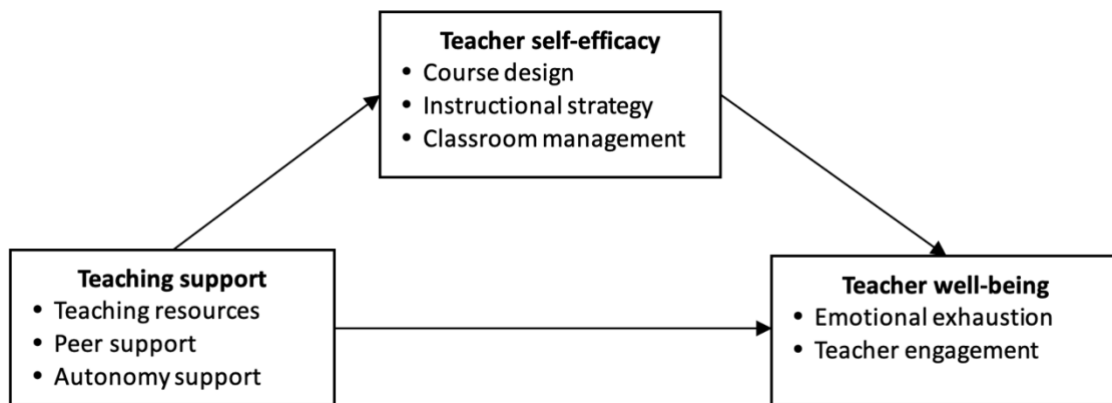

Figure 1. The theoretical framework

Methods

Participants

With the permission of and help from administrators in charge of the teaching staff, an online questionnaire survey was conducted with a convenience sampling approach in May 2021. Teachers were invited to report their feelings about online teaching in the ICT-enhanced teaching environment anonymously and voluntarily. Our samples consisted of 836 university teachers, of whom 420 (50.2%) were females. Participants were recruited from two representative universities: a national research-oriented university (n = 549, 65.7%) and a provincial teaching-oriented university (n = 287, 34.3%). Regarding their years of teaching experience, 139 (16.6%) had less than 5 years of teaching experience, 249 (29.8%) had 6 to 15 years of teaching experience and 448 (53.6%) had more than 16 years of teaching experience. However, 83% of them did not possess online ICT-enhanced teaching experience. A total of 15 (1.8%) held the position of teaching assistants (the starting rank for professionals in higher education institutions in China), while there were also 246 (29.4%) lecturers, 385 (46.1%) associate professors and 190 (22.7%) professors. The participants were sampled across four disciplines: 91 (10.9%) were from science, 240 (28.7%) were from engineering and technology, 379 (45.3%) were from arts and humanities and 126 (15.1%) were from medicine.

Measurement

The questionnaire used in this study comprised two parts. The first was designed to collect demographic information on university teachers. The second part contained three sets of scales that measured teaching support, teacher self-efficacy and teacher well-being (emotional exhaustion and teacher engagement). The items were adapted slightly to fit the ICT-enhanced teaching and scored using a 5-point Likert scale from *totally disagree* (1) to *totally agree* (5).

Teaching support: As the literature has indicated, the scale of teaching support covered three indicators: teaching resources, peer support and autonomy support (Han et al., 2021). We added a preface, "In the ICT-enhanced teaching", prior to the items to emphasise the specific context. Original items of teaching resources (three items, e.g., "The university provides mentoring, training and resources for ICT-enhanced teaching") and peer support (three items, e.g., "Colleagues offer advice on ICT-enhanced teaching") were adapted from the faculty teaching support scale (Han et al., 2018), and that of autonomy support was adapted from Inigo and Raufaste's (2019) autonomy support scale (three items, e.g., "I can decide on specific ways and means to complete teaching tasks"). Higher scores for items indicated higher levels of teaching support.

Teacher self-efficacy: The scale of teacher self-efficacy was adopted from Han et al.'s (2021) study on online teaching environments. We added a preface, "In the ICT-enhanced teaching", prior to the items to emphasise the specific context of this study. It consists of three dimensions: course design (five items; e.g., "I have sufficient ability to teach my courses in ICT-enhanced teaching"), instructional strategy (five items; e.g., "I can teach in ICT-enhanced context according to the level of students") and classroom management (five items; e.g., "I can motivate students to participate in ICT-enhanced learning"). Higher scores for items on the teacher self-efficacy scale indicated greater teacher self-efficacy in ICT-enhanced teaching.

Teacher well-being: This study utilised emotional exhaustion and teacher engagement as two primary indicators of teacher well-being. Emotional exhaustion was assessed by five items corresponding to emotional exhaustion in the Maslach Burnout Inventory – General Survey (Maslach et al., 1997). The items were modified slightly for use in the context of ICT-enhanced teaching. Examples included "I am emotionally drained from ICT-enhanced teaching" and "I feel used up at the end of ICT-enhanced teaching". Higher scores for items on this scale reflected greater emotional exhaustion among university teachers. Teacher engagement was measured using a nine-item shortened version of the Utrecht Work Engagement Scale developed by Schaufeli et al. (2006). The shortened scale contained three dimensions: vigour (three items; e.g., "In ICT-enhanced teaching, I feel bursting with energy"), dedication (three items; e.g., "My ICT-enhanced teaching inspires me") and absorption (three items; e.g., "I feel happy when I am teaching with enhanced technologies intensely"). Higher scores for items on the teacher engagement scale reflected greater engagement with ICT-enhanced teaching amongst university teachers.

Data analysis

First, we examined the validity of each scale using confirmatory factor analysis (CFA) and assessed the reliability of each scale by calculating Cronbach's a coefficient. Second, we calculated descriptive statistics (*M* and *SD*) and factor correlations for the university teachers' teaching support, teacher self-efficacy and teacher well-being. Then, we conducted structural equation modelling (SEM) to identify the relationship between teaching support, teacher self-efficacy and teacher well-being (emotional exhaustion and teacher engagement) in ICT-enhanced teaching. Finally, we used a 5,000 bootstrapping strategy to examine the mediating effects of teacher self-efficacy between teaching support (independent variable) and teacher well-being (dependent variable).

The CFA, SEM and bootstrapping were conducted via AMOS 24.0 with maximum likelihood estimation. Model fit is deemed acceptable if the values of the comparative fit index (CFI) and the Tucker–Lewis index (TLI) exceed 0.90 and the root mean square error of approximation (RMSEA) is smaller than 0.10 (Schermelleh-Engel et al., 2003). In the comparison of alternative measurement models, a better model

fit was indicated by a smaller Akaike information criterion (AIC) and a smaller expected cross-validation index (ECVI) (Schermelleh-Engel et al., 2003; Van De Schoot et al., 2012). Indirect effects are significant if the lower and the upper levels in the 95% confidence intervals do not include zero (Hayes, 2009). Model reliability, descriptive statistics and correlations among the variables were assessed using SPSS 23.0. We explain the results in terms of effect sizes with the following standards: small = 0.10 to < 0.30, medium = 0.30 to < 0.50, large ≥ 0.50 (Cohen, 1988).

Results

Validity and reliability

The CFA results for teaching support (chi square (χ^2) = 135.94, degrees of freedom (*df*) = 24, *p* < 0.001, CFI = 0.98, TLI = 0.98, RMSEA = 0.075) indicated a good model fit, and the factor loadings ranged from 0.76 to 0.95. The three measured dimensions – teaching resources, peer support and autonomy support – showed good internal consistency, with Cronbach's α coefficients of 0.89, 0.94 and 0.94, respectively.

The CFA results for teacher self-efficacy (χ^2 = 470.89, *df* = 81, *p* < 0.001, CFI = 0.97, TLI = 0.96, RMSEA = 0.076) indicated a good model fit. Factor loadings ranged from 0.66 to 0.90. Cronbach's α coefficients were 0.94 (course design), 0.93 (instructional strategy) and 0.91 (classroom management), thus indicating good internal consistency for this scale.

The CFA results for emotional exhaustion (χ^2 = 14.19, *df* = 4, *p* < 0.001, CFI = 0.99, TLI = 0.99, RMSEA= 0.055) showed a good fit to the model data, with factor loadings ranging from 0.75 to 0.94. Cronbach's α coefficient was 0.94, showing good internal consistency.

As the three factors of teacher engagement exhibited very high inter-correlations, we compared the CFA models of teacher engagement as a first-order three-factor model, a first-order one-factor model and a second-order model. The first-order one-factor model (χ^2 = 181.88, *df* = 22, *p* < 0.001, CFI = 0.98, TLI = 0.96, RMSEA= 0.093, AIC = 227.88, ECVI = 0.27) exhibited a superior fit and was retained for further analysis. The factor loadings ranged from 0.70 to 0.93 and Cronbach's α coefficient was 0.95, showing good internal consistency.

Table 1
Descriptive statistics, correlations, factor loadings and Cronbach's α coefficients (N = 836)

	Teaching resources	Peer support	Autonomy support	Course design	Instructional strategy	Classroom management	Emotional exhaustion	Teacher engagement
Teaching resources	(0.89)							
Peer support	0.62**	(0.94)						
Autonomy support	0.59**	0.64**	(0.94)					
Course design	0.50**	0.48**	0.64**	(0.94)				
Instructional strategy	0.53**	0.51**	0.60**	0.75**	(0.93)			
Classroom management	0.55**	0.53**	0.64**	0.70**	0.86**	(0.91)		
Emotional exhaustion	-0.27**	-0.25**	-0.33**	-0.34**	-0.29**	-0.32**	(0.94)	
Teacher engagement	0.54**	0.48**	0.54**	0.51**	0.60**	0.61**	-0.35**	(0.95)
M	3.90	4.03	4.19	4.26	3.94	4.00	2.47	3.61
SD	0.74	0.63	0.60	0.63	0.70	0.64	0.91	0.68
Factor loadings	0.76-0.95	0.89-0.95	0.86-0.95	0.80-0.90	0.80-0.89	0.66-0.89	0.75-0.94	0.70-0.93

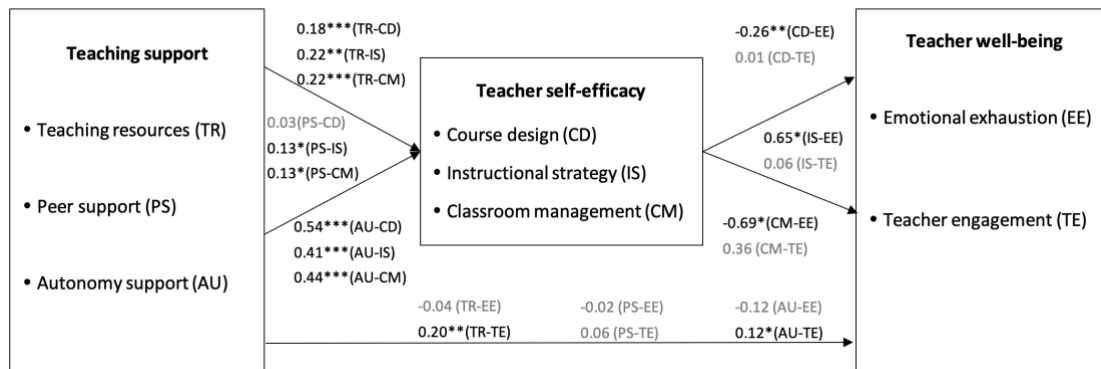*Note*. Cronbach's α coefficients are in parentheses along the diagonal.
**$p < 0.01$.

Figure 2. Effects of teaching support on teacher well-being via teacher self-efficacy (*N* = 836)
Note. Goodness-of-fit indices: χ2 =1737.69, *df* = 627, *p* < 0.001, CFI = 0.97, TLI = 0.96, RMSEA = 0.046.
*p < 0.05. **p < 0.01. ***p < 0.001.

Descriptive and correlation analysis

Overall, the mean scores for teaching support and teacher self-efficacy were higher than the midpoint (3) of the 5-point Likert scale (Table 1). Specifically, of the three dimensions of teaching support, autonomy support (*M* = 4.19, *SD* = 0.60) had the highest mean score, followed by peer support (*M* = 4.03, *SD* = 0.63) and teaching resources (*M* = 3.90, *SD* = 0.74). Of the three dimensions of teacher self-efficacy, course design (*M* = 4.26, *SD* = 0.63) had the highest mean score, followed by classroom management (*M* = 4.00, *SD* = 0.64) and instructional strategy (*M* = 3.94, *SD* = 0.70). For teacher well-being, the mean score for teacher engagement (*M* = 3.61, *SD* = 0.68) was higher than the midpoint (3) of the 5-point Likert scale, while that for emotional exhaustion (*M* = 2.47, *SD* = 0.91) was lower.

In the correlation matrix for the variables, emotional exhaustion had inverse correlations with teaching resources, peer support and instructional strategy with small effect sizes ($0.10 \leq | r | < 0.30$) and with autonomy support, course design, classroom management and teacher engagement with moderate effect sizes ($0.30 \leq | r | < 0.50$). All of the other factors were positively correlated with each other with medium to large effect sizes – ranging from 0.48 to 0.86.

SEM

We performed SEM to examine the relationships between teaching support, teacher self-efficacy and teacher well-being. The SEM results, presented in Figure 2, displayed a good model fit (χ^2 =1737.69, *df* = 627, *p* < 0.001, CFI = 0.97, TLI = 0.96, RMSEA = 0.046). The explained variances of the variables were 0.47 (course design), 0.44 (instructional strategy), 0.49 (classroom management), 0.19 (emotional exhaustion) and 0.49 (teacher engagement).

Specifically, the SEM results indicated that teaching resources were positively associated with three dimensions of teacher self-efficacy and teacher engagement with small effect sizes; peer support was positively associated with instructional strategies and classroom management with small effect sizes; autonomy support was positively associated with three dimensions of teacher self-efficacy with moderate to large effect sizes and with teacher engagement with a small effect size. There were no significant associations between teaching support and emotional exhaustion. The results also indicated that efficacy in course design (β = -0.26, *p* < 0.01) and classroom management (β = -0.69, *p* < 0.05) were negatively linked to emotional exhaustion, whereas efficacy in instructional strategy had a positive link with emotional exhaustion (β = 0.65, *p* < 0.05); teacher self-efficacy had no significant association with teacher engagement.

Mediation analysis based on 5,000 bootstrapping samples (shown in Table 2) revealed that teacher self-efficacy significantly mediated the effect of autonomy support on teacher well-being with small total indirect effect sizes. Although there existed mediating effects of teacher self-efficacy on the relationships between teaching resources and teacher well-being as well as between peer support and teacher engagement, those total indirect effects were very small (< 0.10) and had no practical significance.

Table 2
The total indirect effects of teacher self-efficacy (N = 836)

	Indirect effects	Estimate	95% Confidence intervals	
			Lower 2.5%	Upper 2.5%
TR-EE		**-0.06***	-0.15	-0.01
	TR-CD-EE	-0.05***	-0.10	-0.02
	TR-IS-EE	0.14*	0.02	0.50
	TR-CM-EE	-0.15**	-0.48	-0.04
TR-TE		**0.09****	0.05	0.16
	TR-CD-TE	0.00	-0.03	0.03
	TR-IS-TE	0.01	-0.15	0.14
	TR-CM-TE	0.08	-0.02	0.29
PS-EE		-0.01	-0.08	0.05
	PS-CD-EE	-0.01	-0.04	0.02
	PS-IS-EE	0.08*	0.01	0.30
	PS-CM-EE	-0.09*	-0.32	-0.01
PS-TE		**0.05***	0.01	0.12
	PS-CD-TE	0.00	-0.01	0.01
	PS-IS-TE	0.01	-0.09	0.09
	PS-CM-TE	0.05	-0.01	0.22
AU-EE		**-0.18****	-0.32	-0.10
	AU-CD-EE	-0.14**	-0.26	-0.06
	AU-IS-EE	0.26*	0.04	0.76
	AU-CM-EE	-0.30*	-0.83	-0.06
AU-TE		**0.19****	0.11	0.29
	AU-CD-TE	0.00	-0.07	0.09
	AU-IS-TE	0.03	-0.29	0.24
	AU-CM-TE	0.16	-0.06	0.53

Note. Bold items indicate significant total indirect effects. TR = teaching resources; PS = peer support; AU = autonomy support; CD = course design; IS = instructional strategy; CM = classroom management; TE = teacher engagement; EE = emotional exhaustion.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Discussion

This study contributes to knowledge on the applicability of the interactionist model in assessing teacher well-being within the context of ICT-enhanced teaching, particularly during times influenced by the pandemic. Under the guidance of the interactionist model, the study represents a crucial step towards comprehending how university teachers' well-being related to ICT is influenced by both individual factors (such as teacher self-efficacy) and contextual factors (including teaching support). Therefore, it provides further evidence to support the validity of the model. Specifically, the identified regression pathways emphasise both the theoretical and practical significance by combining teaching support (contextual factor) and self-efficacy (individual factor) in promoting teacher well-being when utilising ICT for instruction. The study also confirms that teacher self-efficacy plays a significant mediating role in the relationship between autonomy support and teacher well-being in the context of ICT-enhanced teaching, particularly the online teaching necessitated by the pandemic.

Characteristics of teacher well-being in ICT-enhanced teaching

Concerning teacher well-being, the Chinese university teachers in our study reported a high level of work engagement and a low level of emotional exhaustion. That is, they exhibited a remarkable degree of enthusiasm and energy alongside a notable absence of emotional depletion in the ICT-enhanced teaching. The enhanced integration of ICT into teaching practices neither impaired teacher engagement nor caused them significant emotional exhaustion. Although some researchers have indicated that the interdependent-based East-Asian views of well-being (focusing on social relationships) might be different from the independent-based European-American views (emphasising personal freedom and rights) (Uchida et al., 2015), our results are consistent with those of recent research revealing low levels of burnout among German university teachers delivering ICT-enhanced online teaching during the pandemic (Daumiller et al., 2021).

This result may be related to the attitudes of the university teachers in our study towards ICT-enhanced teaching during the pandemic. As reported in our study, over 80% of the participating teachers did not have fully ICT-enhanced online teaching experience, and the pandemic was the first instance in which the majority of university teachers had to deliver courses exclusively online in ICT-enhanced teaching (Ahmed, 2021). Although Chinese teachers were under heavy pressure to redesign their courses, adjust their teaching strategies and carry out online activities, they were provided with abundant resources by the government and administrators and also had more autonomy over their teaching (Zhou & Li, 2020). As indicated by Daumiller et al. (2021), with such support, university teachers probably viewed ICT-enhanced teaching during the pandemic as a challenging and useful task as opposed to a negative experience, leading them to feel engaged rather than exhausted. Therefore, we may conclude that ICT-enhanced teaching during the pandemic neither reduced the Chinese university teachers' engagement nor caused them emotional exhaustion.

Relationships between teaching support, teacher self-efficacy and teacher well-being

Our results revealed that teachers' perceptions of teaching resources and autonomy support is positively related to all dimensions of teacher self-efficacy in ICT-enhanced teaching. This suggests that access to more resources and greater autonomy make teachers feel more confident in their ability to design courses, implement teaching strategies and manage classrooms in ICT-enhanced teaching. According to Tschannen-Moran and Hoy (2007), contextual factors, such as available resources and constraints, were significant for teachers, especially in ICT-enhanced teaching (Moreira-Fontán et al., 2019; Scherer & Siddiq, 2015). Thus, greater access to teaching resources and fewer constraints on teaching may enhance teachers' efficacy (Moreira-Fontán et al., 2019). Recent empirical studies have shown that following ICT-enhanced teaching during the pandemic, Chinese teachers were provided with numerous teaching materials and greater flexibility and control in carrying out their teaching according to their specific needs (Zhou & Li, 2020). Such factors may have enhanced their confidence in ICT-enhanced teaching, particularly in online teaching.

Additionally, the positive link between teaching resources and autonomy to teacher engagement revealed that sufficient teaching resources and empowered autonomy support also increased university teachers' enthusiasm, dedication and involvement in ICT-enhanced teaching. Research indicated that a supportive working environment that offered more resources and control for the employees foster their willingness to be immersed in the tasks at hand and result in positive consequences (Bakker &Demerouti, 2017). They were also found to be more engaged and self-efficacious in a more supportive environment (Schaufeli & Taris, 2014). It is also true in the educational field for teacher well-being (Hascher & Waber, 2021). Therefore, when provided with greater resources and autonomy, university teachers would feel vigorous and dedicated to their teaching in ICT-enhanced teaching.

Mediating effects of teacher self-efficacy

Our results not only corroborate the significant associations between teaching support, teacher self-efficacy and teacher well-being but also unveiled the mediating role of teacher self-efficacy in the link between teaching support and teacher well-being, thereby validating the proposed theoretical framework of this study within the purview of the interactionist model of teacher well-being. Specifically, the inclusion of teacher self-efficacy as a mediator increased the explanatory power of autonomy support on teacher well-being in ICT-enhanced teaching. For university teachers who were provided with more autonomy and flexibility in ICT-enhanced teaching, the effects of teaching support on increased engagement and decreased emotional exhaustion were greatly actualised through the increased teacher self-efficacy. Teachers with high self-perceived competence in ICT-enhanced teaching may feel optimistic about their ability to deal with unanticipated events and believe that good things will eventually happen to them, such teachers may be more persistent in and dedicated to their work and feel less depleted (Bakker & Demerouti, 2017; Ventura et al., 2015). Research has also emphasised the pivotal role of autonomy support in online teaching, revealing that teachers who are empowered with increased autonomy in online teaching environments are more confident in and dedicated to online teaching practice (Peach & Bieber, 2015).

Surprisingly, in contrast with the previous result which indicated that teacher self-efficacy can alleviate emotional exhaustion among university teachers (Skaalvik & Skaalvik, 2014; Ventura et al., 2015), our study found that teacher self-efficacy – specifically in the area of instructional strategy – is positively related to emotional exhaustion in ICT-enhanced teaching. This suggests that university teachers may feel more emotionally drained when they are more confident about strategies used in ICT-enhanced teaching. This unexpected result may have been related to university teachers' perceptions of instructional strategies in ICT-enhanced teaching. Instructional strategies have been argued to be central to the facilitation of learning (Chang et al., 2011). When all courses were exclusively taught in the ICT-enhanced environment during the pandemic, teachers were provided with a variety of training programs and lectures on online teaching strategies by governments and administrators (Zhou & Li, 2020). However, teachers may also feel overwhelmed, exhausted and under pressure when – in addition to their daily duties – they are confronted with numerous training programmes and lectures on online teaching platforms, teaching methods and assessments in the ICT-enhanced teaching environment (Aadmi-Laamech et al., 2022). Thus, attempts to improve efficacy in instructional strategies via new initiatives should be sensitive to teachers' existing workloads.

Limitations and directions for future research

The present study yields abundant findings on the well-being of university teachers engaged in ICT-enhanced teaching during the pandemic; nevertheless, it is crucial to acknowledge certain limitations that underscore potential avenues for future research. First, due to its cross-sectional and exploratory nature, the study was insufficient to confirm causal relationships between university teachers' teaching support, teacher self-efficacy and well-being in ICT-enhanced teaching. A longitudinal study design would help to elucidate the directionality of these relationships in future research. Additional limitations of the study pertain to the potential biases associated with self-rated measurements. More objective data could be

collected in future research with alternative methods, such as a mixed-method design. Third, although some insights have been gained regarding the improvement of ICT-related teaching, it is important to note that the generalisability of these results may be limited due to the focus on the university context in a single country. Future research may expand investigations into teacher well-being in ICT-enhanced teaching at an international level. Last but not least, the correlation and regression analyses revealed an inconsistency in the associations between emotional exhaustion and instructional strategy, suggesting a potential avenue for future research to explore additional contributing factors that impact teacher well-being.

Conclusion and practical implications

The results of this study, which primarily focused on ICT-enhanced online teaching during the pandemic, provide valuable insights into Chinese university teachers' support for teaching, their self-efficacy and their overall well-being in various instructional modes including traditional face-to-face teaching, blended teaching and online teaching. The potential necessity for ICT-enhanced teaching may make an appropriate skillset indispensable for both university teachers' capabilities and professional development programs across faculties. Therefore, our results offer crucial guidance to promote teacher well-being as well as the effectiveness of ICT-enhanced teaching.

The positive associations between university teachers' teaching support, teacher self-efficacy and teacher well-being highlight the significant role played by teaching resources and autonomy support in enhancing teacher competence and well-being in ICT-enhanced teaching practices in ICT-enhanced online teaching context. Therefore, it is worth noting that teaching resources and autonomy support significantly contribute to teaching effectiveness and teacher engagement in online instructional settings as well as face-to-face teaching which was examined in previous research. As such, administrators could consider providing more resources geared towards enhancing university teachers' confidence in their teaching abilities and their well-being in ICT-enhanced teaching practices. For instance, different types of teaching platforms (e.g., communicative platforms, document-delivery platforms and webcasting platforms), more teaching materials and technologies and electronic databases for ICT-enhanced teaching could be provided. University teachers could also be granted considerable autonomy to select their preferred teaching platforms, methods and materials to meet their specific needs and preferences.

Given the mediating role of teacher self-efficacy on the links between teaching support and teacher well-being, administrators should consider enhancing teachers' efficacy in ICT-enhanced teaching – especially in the areas of course design, instructional strategy and classroom management. This could be explored through diverse forms of support, such as online training programs, lectures and mentoring. However, the positive relationship between efficacy in instructional strategy and emotional exhaustion should serve as a warning to administrators to avoid introducing excessive and burdensome initiatives in this area. Finally, to alleviate their emotional exhaustion, university teachers could be encouraged to focus on their specific needs when conducting ICT-enhanced teaching to prevent them from becoming overwhelmed by the vast amount of information available to them.

Author contributions

Jiying Han: Conceptualisation, Methodology, Supervision, Proofreading; **Chao Gao:** Formal analysis, Writing – original draft, Visualisation, Revision.

Acknowledgements

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