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Digitalization in education: Developing tools for effective learning and personalisation of education

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Digitalization in education: Developing tools for effective learning and personalisation of education

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Editorial: Digitalization in education: developing tools for effective learning and personalisation of education

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digitalization, effective learning, personalization, learning environment, digital tools

Editorial on the Research Topic
Digitalization in education: developing tools for effective learning and personalisation of education

Introduction

Technology-driven trends in the modern society have transformed the ways humans think and communicate. The latest technological artifacts and devices have a profound impact on the forms of interaction between individuals and also significantly influence the process of co construction of knowledge. The COVID-19 pandemic induced experience of remote teaching has significantly contributed to the widespread use of digital technologies in teaching—learning processes, faculty communications, research collaborations, conferences, and workshops. The crisis also led to an understanding of the uncertainty of returning to conventional normal and paved way for a new normal ushered by the COVID-19 pandemic. Such transformations create a need for Institutions to prioritize identification of perspective models of digitalization in education (Salmon, 2013). Teachers, teacher educators, and policymakers need to collaborate for co-constructing the technology-assisted classroom that will gradually evolve from teaching supplements to pivotal support for creating a personal learning environment (Dabbagh and Kwende, 2021).

This article Research Topic aims at examining teachers' experience in implementation of computer technologies and exploring gaps and challenges in the current academic educational practice with regard to use of digital tools. Various elements of digital environment including online courses, e-resources, virtual and augmented reality, artificial intelligence and robotics have become an integral component of learning and fostering students' skills, practical teaching experience and effective professional training. It is imperative that aspects of e education are discussed at the global level in order to stimulate creation of personal learning environments, meet inclusive learning needs, support life-long education and identify relevant digital technologies for upgradation of pedagogical methods and teacher strategies in education.

The Research Topic welcomed papers that explore the challenges and perspectives of using digital technologies in teacher education pedagogies and design tools for

personalization of learning pathways. Are collected works that draw upon theories and innovative trends in implementation of digital resources in educational environments; explore effective teacher strategies for engaging students in the educational process; discuss global pedagogical approaches for knowledge construction and methods of learning evaluation.

The articles allow readers to outline—from multiple investigative perspectives and international contexts—some strands that today characterize the actual scientific debate on digitalization in education.

Challenges and perspectives of using technologies in education and design of digital tools for teacher preparation and professional development

- The study by Karkina et al.—inspired by Shulman's theory and conducted at the Kazan Federal University—focuses on the development of professional skills of future music teachers within the MOODLE e-learning environment.
- Muchnik-Rozanov et al.'s study the emotional response of 32 in-service teachers to adopting Mobile Learning (ML) while attending ML training during the COVID-19 pandemic. It highlights the importance of factors such as the teachers' degree of emotional immersion and the use of emotion words.
- Pozas et al.'s investigation explores teachers' emotional state during emergency remote teaching (ERT) in Germany with respect to teachers' technology readiness profiles and gender. It discusses the implications of the findings for initial teacher education and professional development.

Designing flexible, adaptive and meaningful educational digital resources to accommodate students learning, work and life goals

- Campillo-Ferrer and Miralles-Martinez's article describes a study realized at the University of Murcia. It examines the effectiveness of Webquest—as a gamification resource—on developing teacher students' skills in organizing and planning learning.
- Aboud's study conducted with 120 teachers from Saudi Arabia, Bahrain, and the United Arab Emirates highlighted that gifted students tend to value teachers more for their personal characteristics than for their professional ones even in online learning environments.
- The article by Zhang et al. presents the pilot study conducted on 24 Chinese university students who experienced learning through Danmu videos. It noted motivating factors—such as information seeking, social presence and perceived entertainment—and obstacles—such as information pollution and attention failure.

Preparing professionals for a sustainable future and constructing computer aided educational ecosystems

- Silva's article presents the study conducted at the University of Verona (Italy) on the promotion of transversal skills of faculties through programs inspired by a systemic and multifocal approach and implemented in technological environments.
- The article by Asensio and Duñabeitia discusses the advantages, disadvantages and implications that the transition from paper-and-pencil to computer-based cognitive assessments (CCA) have with respect to the educational intervention practice of different professionals.
- The investigation of Du et al.—conducted with 347 teachers from six universities in eastern China—brings out that teachers' performance in online teaching is significantly influenced by satisfaction, perceived usefulness and perceived ease of use of online teaching.

Digital tools for educational assessment and evaluation of learning outcomes

- The study by Goto et al. conducted in primary and secondary schools in Japan demonstrates that the use of computer-adaptive tests does not reinforce students' anxiety regarding taking the test and could therefore be introduced more into school assessment practice.
- Chun and Yunus' study investigates the factors influencing English as a Second Language (ESL) teachers' behavioral intentions (BI) toward technology use in the post-COVID-19 era in Malaysia. It highlights the importance of performance expectancy (PE), effort expectancy (EE), and social influence (SI).

Conclusion

The collective insights from these diverse studies underscore the pivotal role of technology, emotional engagement, and professional development in modern education. Studies highlight how digital platforms can significantly enhance teacher training and support, illustrating the need for robust technological readiness and emotional support systems for educators. These studies also stress the importance of innovative, student-centered digital resources, showing how gamification and multimedia tools can effectively engage students and foster deeper learning. The research underscores the necessity for adaptive learning environments that cater to students' personal and academic needs, emphasizing the value of personal attributes in educational settings. The importance of satisfaction, perceived usefulness, and ease of use in online teaching environments is highlighted, reinforcing the need for continuous improvement in digital education tools. This Research Topic provide a comprehensive understanding of the multifaceted approaches required to enhance professional

development, create engaging and flexible learning environments, and implement effective digital assessment tools, ultimately contributing to the advancement of education in a rapidly evolving digital age.

Author contributions

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"The whole is greater than the sum of its parts" – Exploring teachers' technology readiness profiles and its relation to their emotional state during COVID-19 emergency remote teaching

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With the rapid spread of the Coronavirus (COVID-19), schools around the world came to a shutdown. This resulted in an abrupt transition from face-to-face instruction to emergency remote teaching (ERT), resulting in numerous challenges that have greatly affected teachers. Even though research has identified key factors for teachers to effectively implement ERT in the context of the COVID-19 school shutdown, there is still little research on the factors (and their interrelations) that account for the differences between teachers' experiences. Following a theoretical model of technology readiness, this study aimed to investigate teacher profiles based on domains of technology acceptance, technology competence and technology control. In addition, this study seeks to explore whether teachers' emotional state during ERT varies between the teacher technology readiness profiles. A total of 124 teachers participated voluntarily in an online survey stemming from the research project "*Students-Parents-Teachers in Homeschooling*" in Germany. Results from a two-step cluster analysis revealed three distinct teacher technology readiness profiles. Moreover, the findings also revealed gender differences between the three technology readiness profiles. Lastly, an analysis of variance indicated that teachers' positive emotional state during ERT varied significantly across the clusters. Implications of the results for teacher education and teacher professional development, as well as further lines of research are discussed.

KEYWORDS

teacher technology readiness, teacher profiles, positive state, negative state, emergency remote teaching

Introduction

Teaching has been considered as one of the most stressful professions (MacIntyre et al., 2020; Ozamiz-Etxebarria et al., 2020), and mastering it during the school shutdown imposed by the COVID-19 pandemic has only placed even more challenges to a teacher's job (Klapproth et al., 2020). In order to hinder the rapid spread of COVID-19, schools worldwide were forced to implement ERT as a temporary solution [ERT is related to emergency remote education which is considered as a branch of online learning and homeschooling (Bozkurt and Sharma, 2020)], shifting face-to-face instruction to online learning (Bozkurt and Sharma, 2020; Seufert et al., 2021). Important to recall is that teaching in an online environment does not only require that teachers have the appropriate technological skills and competencies, but also it also implies that teachers must implement a completely different pedagogical approach than teaching face-to-face (Gurley, 2018). Recent research within the context of ERT during COVID-19 has pointed out at the fact that besides teachers' digital competencies (König et al., 2020; Sá and Serpa, 2020) and previous experiences with ICT (van der Spoel et al., 2020), technology readiness was strongly related to how educators mastered and coped with the challenges during ERT (Adov and Mäeots, 2021). According to van der Spoel et al. (2020), technology readiness is a key teacher professionalization factor when it comes to educational technology integration. However, teachers' technology readiness does not only support the successful and meaningful integration of technology into their teaching practice, but it can also impact their emotional state or experiences (Kim et al., 2019). Several international studies have indicated that teachers who were not familiar with online teaching formats experienced more challenges and worries, and in consequence, a significant negative impact in their emotional state (Sahu, 2020; Sokal et al., 2020; Baker et al., 2021). Thus, it is not surprising that multiple studies have also indicated that teachers report an increase of stress, anxiety, and exhaustion (Al Lily et al., 2020; Li et al., 2020; Prado-Gascó et al., 2020; Zhou and Yao, 2020; Karakose et al., 2021). Bearing in mind the decisive role that the variable of teacher technology readiness has not only on their use of technology for instructional purposes, but as well on their emotional experiences, the current study seeks to contribute to the research field by exploring profiles of teachers' technology readiness. Furthermore, the present study will explore potential differences on teachers' emotional state across the identified profiles. Understanding the relation between teachers' technology readiness and their emotional state gives us the opportunity to acquire a deeper knowledge of which aspects should be addressed to support teachers' development of digital competencies, motivation, and readiness in order to foster their purposeful and effective integration of technology not only during the pandemic but as well after it (Adov and Mäeots, 2021). The following section will introduce the factor of technology readiness, followed by a brief discussion on the relevant research and findings on teachers' emotional state during ERT in the COVID-19 pandemic.

Technology readiness

Different theoretical models on technology integration, such as the technology acceptance model (TAM; Venkatesh and Bala, 2008), theory of reasoned action (Ajzen, 1991), or the "Will, Skill, Tool" model (Knezek et al., 2003), have highlighted people's technology readiness as a crucial factor for the successful use of technology (Petko et al., 2018; Howard et al., 2021). Moreover, such theoretical considerations have also been empirically supported by findings from multiple educational research studies (Petko et al., 2018). The construct of technology readiness originates from the TAM (Venkatesh and Bala, 2008), which explains the use of technology through the concept of technology acceptance, and theorizes that perceived usefulness and simplicity of technology influence both attitudes and beliefs toward technology usage (Venkatesh and Bala, 2008). Neyer et al. (2012), proposed a model of technology readiness in terms of three dimensions: technology acceptance (attitude reflecting the subjective appraisal of technological progress/perceived value), technology competence (assessment of one's own technology-relevant abilities), and technology control (subjective expectation of the results of technology-relevant actions). Technology readiness differences at the individual level based on these three facets should not only substantially associated with variables such as self-efficacy and emotional stability, but also with an individual's actual technology use (Neyer et al., 2012). Thus, based on such theoretical and empirical considerations, it can be assumed that teachers who are successful and effective in using technology are convinced that technology is beneficial for both instructional purposes and students learning, recognize the added value of technology, consider themselves competent to use digital technology (Woltran et al., 2022), as well as have positive control beliefs and experiences in technology-relevant situations (i.e., user friendliness; Amhag et al., 2019; Adov and Mäeots, 2021).

Previous research on teachers' technology readiness has shown that teachers hold a moderate level (Summak et al., 2010; Badri et al., 2014). In detail, Badri et al. (2014) reported that teachers scored relatively high in optimism and innovativeness. According to the authors, such factors are related to positive views about technology and an increase of control using new technologies. Additionally, findings by Summak et al. (2010) revealed significant differences between technology readiness and gender, indicating that male teachers demonstrated a higher technology readiness level than their female counterparts. A recent qualitative study by Adov and Mäeots (2021) in Estonia conducted during the COVID-19 pandemic lockdown, revealed that teachers varied in their levels of technology readiness, ranging from a low willingness to use technology in their teaching to a more open and positive view of the possibilities that technology provided. Further in-depth analyses indicated a relation between teachers' technology readiness level and their technology integration during ERT. Similarly, a study by Howard et al. (2021) which explored teacher data from 20 countries, also indicated that teachers have different levels of technology readiness, ranging

from low to high readiness. Interestingly, results from their study also indicated that most teachers had a medium level of technology readiness.

Stephan et al. (2019) argue that technology readiness is not only associated to the frequency of technology use, but also, to the user's affective experience. With this background, a recent study by Händel et al. (2020) explored higher education students' technology readiness and emotional experiences during emergency remote education in the COVID-19 pandemic. Findings from this study revealed a correlation between students' technology readiness and their self-reported emotional state, where students who held higher levels of technology readiness reported less tension, worries, and stress. Likewise, a study by Schneider et al. (2021) found an effect of pre-service (student) teachers' technology readiness on their emotional state during COVID-19; however, this effect was smaller when compared to the results by Händel et al. (2020). Taken together, it may be assumed that teachers' technology readiness could be a crucial condition of their emotional experience and adaptive technology use.

Emotional state

The construct of emotion refers to a "multifaceted experience in which affective, cognitive, physiological, motivational, and expressive processes combine into an emotional episode" (Knörzer et al., 2016, p. 97). In this sense, an emotion is characterized by an intense but rather short affective state (Shuman and Scherer, 2014). Thus, the short duration of emotion can in return lead to short-term changes of emotional states (D'Mello and Graesser, 2012). Watson and Tellegen's (1985) proposed two general activation systems of affect, with positive and negative affect as two unipolar dimensions. Such theoretical framework was based on the Circumplex Model of Affect developed by Russell (1980) who conceptualized two orthogonal dimensions. Tellegen et al. (1999) further modified Russell's model by differentiating between positive (PA) and negative (NA) activation. In this sense, PA and NA represent unipolar states of activation, "where high PA comprises positively valued states with a high degree of activation (e.g., enthusiastic); at the low end are negatively valued states characterized by low PA (e.g., dull). Analogously, high NA comprises negatively valued states with a high degree of activation (e.g., distressed); at the low end are positively valued stated characterized by low NA (e.g., relaxed)" (Schreiber and Jenny, 2020, p. 2). At the behavioral level, PA is associated with approaching behavior, while NA is related to avoidance (Watson et al., 1999).

With regard to teachers' emotional state during ERT in the COVID-19 context, findings from a study by Schwab and Lindner (2020) revealed that Austrian teachers reported feeling far more stressed when compared to before the pandemic. Similarly, a study conducted during the first school shutdown in Germany, Eickelmann and Drossel (2020) reported that 34% of the teachers surveyed indicated that they experienced ERT as a burden. Additionally, findings from Portillo et al. (2020) indicate that teachers perceived a higher workload during the lockdown which had made them experience negative emotions. When exploring teachers' PA and NA, results from Letzel et al. (2020) study revealed a significant increase in teachers' NA during ERT. Although such research has investigated teachers' emotional state during ERT, there is still however, a lack of information when it comes to understanding the factors that account for such impact. For instance, it is unclear why some teachers experienced more stress, strain and worries, whether others were able to manage ERT in a more successful manner. In light of the aforementioned theoretical background and outcomes of previous studies described in the precedent sections, it can therefore be assumed that teachers' technology readiness might play a role in teachers' emotional state.

The present study

The immediate health measures imposed to reduce the spread of COVID-19 forced educational institutions to implement ERT. As a result, a teachers' job was drastically changed from face-to-face instruction, to having to set up online instruction using the resources at hand. Unsurprisingly, teachers have experienced adverse consequences that have had a significant negative impact on their emotional state (Sahu, 2020; Sokal et al., 2020; Baker et al., 2021). Even though there are multiple studies describing teachers' emotional experiences and challenges during ERT in the context of the COVID-19 school shutdown (Huber and Helm, 2020; Klapproth et al., 2020), there is still a lack of research on how teachers' technology readiness contributed to the impact on teachers' emotional state. Against this background, the present study sought to investigate potential teacher profiles based on the different technology readiness domains (Neyer et al., 2012). Furthermore, since technology readiness could be assumed to play a role in teachers' emotional experiences during ERT, this study attempts to explore whether teachers' emotional state varies between the teacher technology readiness profiles. The research questions guiding the study were:

- Can teacher groups be identified differing from one another in terms of technology readiness?
- Do teachers' emotional state during emergency remote teaching (in the context of COVID-19) differ among the teacher groups?

Materials and methods

Participants and procedure

This study uses data from 124 teachers (78% female) who participated in an online survey stemming from the research project *Student-Parents-Teachers* in Homeschooling (abbreviated as SCHELLE following its German title ***Sch**üler-**El**tern-**Le**hrer* for a detailed overview of the SCHELLE project and its design please refer

to Letzel et al., 2020) conducted in the first COVID-19 school shutdown between May and June 2020. The teachers had a mean value of 38.02 years and an average of 10.81 years of teaching experience (SD = 7.37). The sample covered teachers from all school tracks and stages prevalent in the German school system: advanced (academic track) secondary school ($N = 32$), intermediate secondary schools ($N = 28$), comprehensive schools ($N = 26$), primary school ($N = 21$), special school ($N = 4$) and other school forms (i.e., vocational education school) or missing ($N = 13$).

Instruments

Technology readiness

Teachers' technology readiness was measured using the Technology Readiness Questionnaire from Neyer et al. (2012). The scale is composed of three sub-scales underlying the following constructs: technology acceptance (*I am very curious when it comes to new technology developments*; $\alpha = 0.83$), technology competence (*I have often fear to fail when dealing with modern technology*; $\alpha = 0.85$), and technology control (*It depends essentially on me whether I am successful using modern technology*; $\alpha = 0.72$). All sub-scales are based on a 5-point Likert scale ranging from 1 = *strongly disagree* to 5 = *strongly agree*.

Emotional state

To assess teachers' emotional state during emergency remote teaching, the Positive and Negative Activation and Valence (PANAVA) short-form scales from Schallberger (2005) were applied. The PANAVA consists of two scales: positive activation (PA; $\alpha = 0.76$) and negative activation (PA; $\alpha = 0.65$). The PA and NA comprise four bipolar items, respectively, rated on a 6-point Likert scale. To this end, participants received the instruction, "*How do you experience your day to day teaching work since homeschooling started because of COVID-19? Since homeschooling I feel…*," and were asked to rate accordingly their emotional states.

Data analysis

Statistical analyses were conducted in IBM SPSS Statistics 27. First to examine teachers' technology readiness and emotional state, descriptive analyses and *t*-tests were performed. Furthermore, to explore the first research question, a two-step cluster analysis was conducted (Field, 2013). As a first step, a hierarchical cluster analysis using Ward's method and squared Euclidean distance was performed to identify the number of possible profiles of teachers (Hair, 2010; Yim and Ramdeen, 2015). The clustering variables were the three scales stemming from the Technology Readiness (Neyer et al., 2012) instrument: technology acceptance, technology competence, and technology control. The second step consisted of a *k*-means procedure to assign pre-service teachers to their profile and was followed up by an additional discriminant analysis in order to validate the number of clusters. Further analyses included the examination of the relationship between the affiliation with the particular cluster and teachers' sociodemographic variables (i.e., age, gender, teaching experience, and school track). Finally, to explore group difference in emotional state variables relative to cluster membership, mean differences between the groups on the PA and NA scales were analyzed using one-way variance analyses (ANOVA; Rutherford, 2011).

Results

Teachers' technology readiness and emotional state

Mean and standard deviation scores were calculated to determine teachers' technology readiness. As shown in Table 1, the values for teachers' technology acceptance, competence, and control were between 3.66 and 4.16. As the theoretical mean of the scales was 3, the results from the one sample *t*-tests indicate that teachers accept technology, feel competent, and perceive a significantly positive control expectation of technological instruments and process. Finally, *t*-tests assessing differences in gender for the variables under study revealed that, in comparison to male participants, female teachers are less acceptant of technology ($M = 3.54$; SD = 0.85), $t(121) = -2.91$, $p < 0.01$, perceive themselves less competent, ($M = 4.06$; SD = 0.80), $t(121) = -2.82$, $p < 0.01$, and consider to have less control of technological instruments and processes, ($M = 3.70$; SD = 0.66), $t(121) = -2.55$, $p < 0.05$. With regard to teachers' emotional state during emergency remote teaching, no significant difference to the theoretical mean was found for teachers' PA or NA.

Teacher technology readiness profiles: Cluster analysis

In order to identify teacher groups, a hierarchical cluster analysis was performed to identify the clusters related to the dimensions of technology readiness. The dendrogram suggested a two- or three-cluster solution. Second, in order to assign the teachers into their readiness profile, a *k*-means cluster analysis was conducted. Based on the variation between the clusters, on the one hand, and the theoretical framework, on the other hand, a

TABLE 1 Means, standard deviations, one sample *t*-statistics and effect size ($N = 124$).

Variables	*M*	SD	*t*(122)	*p*	Cohen's *d*
1. Technology acceptance	3.66	0.87	8.39	<0.001	0.87
2. Technology competence	4.16	0.79	16.27	<0.001	0.79
3. Technology control	3.78	0.67	12.81	<0.001	0.67
4. PA	3.63	0.94	1.48	n.s.	–
5. NA	3.60	0.95	1.14	n.s.	–

three-cluster solution was identified and chosen. Finally, a discriminant analysis was performed where two discriminant functions were identified. The first function showed a canonical correlation of $R = 0.92$ (eigenvalue = 5.78; Wilks Lambda = 0.12; $p < 0.001$; explained variation 95.7%), the second function showed $R = 0.45$ (eigenvalue = 0.26; Wilks Lambda = 0.80; $p < 0.001$; explained variation 4.3%). In total, 96.7% of the cases grouped by the cluster analysis were correctly classified; accordingly, 3.3% cases were reassigned. The final clusters are composed as follows: cluster 1, the smallest, included 28 teachers (23%), cluster 2, the largest, included 65 teachers (52%), and cluster 3 included 31 teachers (25%). As shown in Table 1, one-way ANOVA with post-hoc analyses indicated that the three technology readiness scales significantly varied within clusters, and therefore, these profiles were valid.

The following section offers a description of the three clusters, while Figure 1 visually presents the teacher profiles:

- Cluster 1: teachers in the first cluster were characterized by the lowest mean scores for all technology readiness scales. In particular, technology acceptance was marked by a low value that differed strongly from the other teacher groups. However, teacher scores for the technology competence and control scales were about the average scale value. Thus, it can be assumed that teachers in this profile perceive themselves moderately competent and with control of technological process, nevertheless, are less acceptant of technology and do not fully recognize its importance, usefulness, and added value.
- Cluster 2: In general, teachers in this cluster indicated high mean values in the three technology readiness scales; however, their mean score values were lower than cluster 3. A particular distinctive characteristic from this cluster is, that in comparison to their mean scores on the technology acceptance and control scales, teachers here reported a considerably higher mean value for their technology competence.
- Cluster 3: teachers in the third cluster were characterized by the highest attribute level, exhibited equally for all technology readiness scales. This indicates that such teachers perceived themselves to be acceptant of

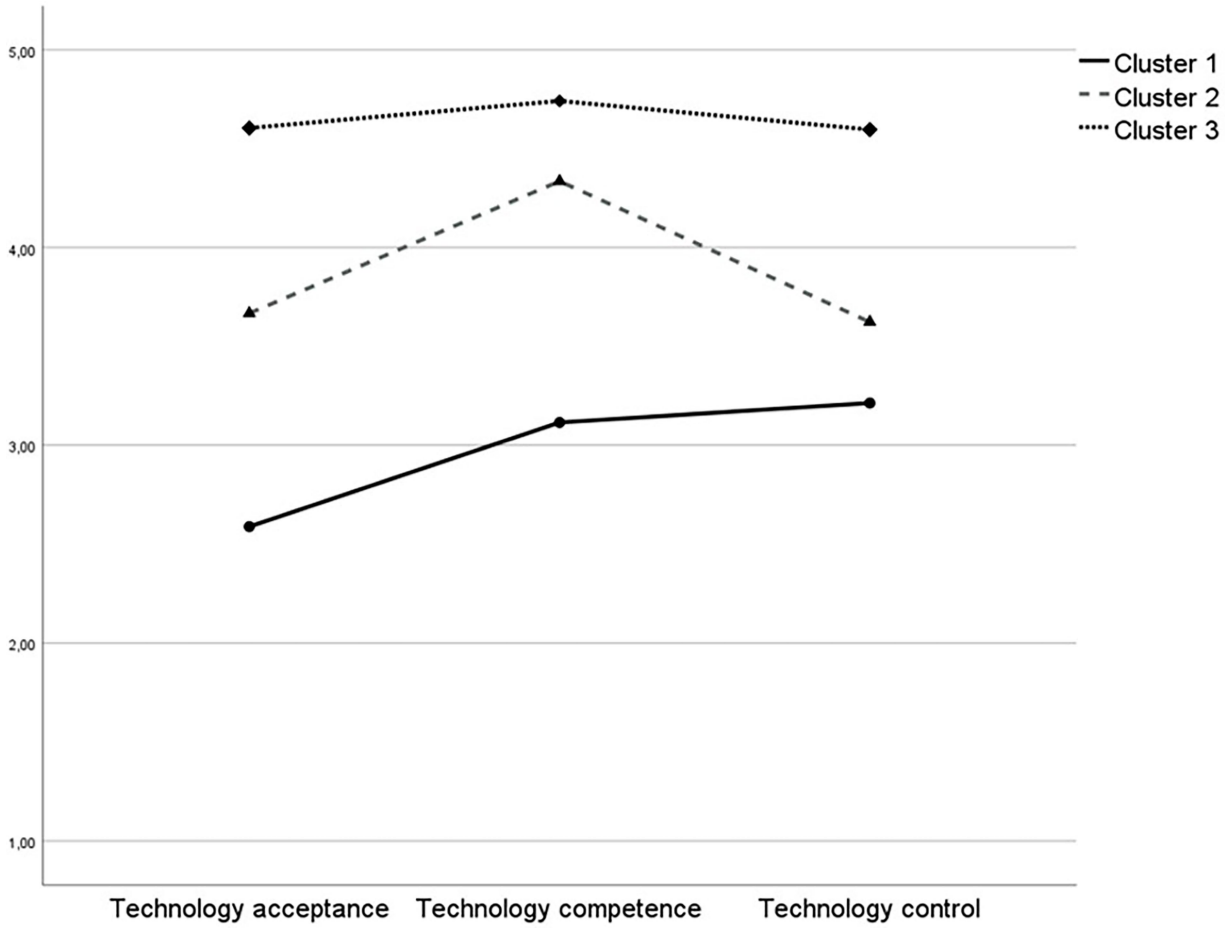

FIGURE 1
Technology readiness teacher clusters.

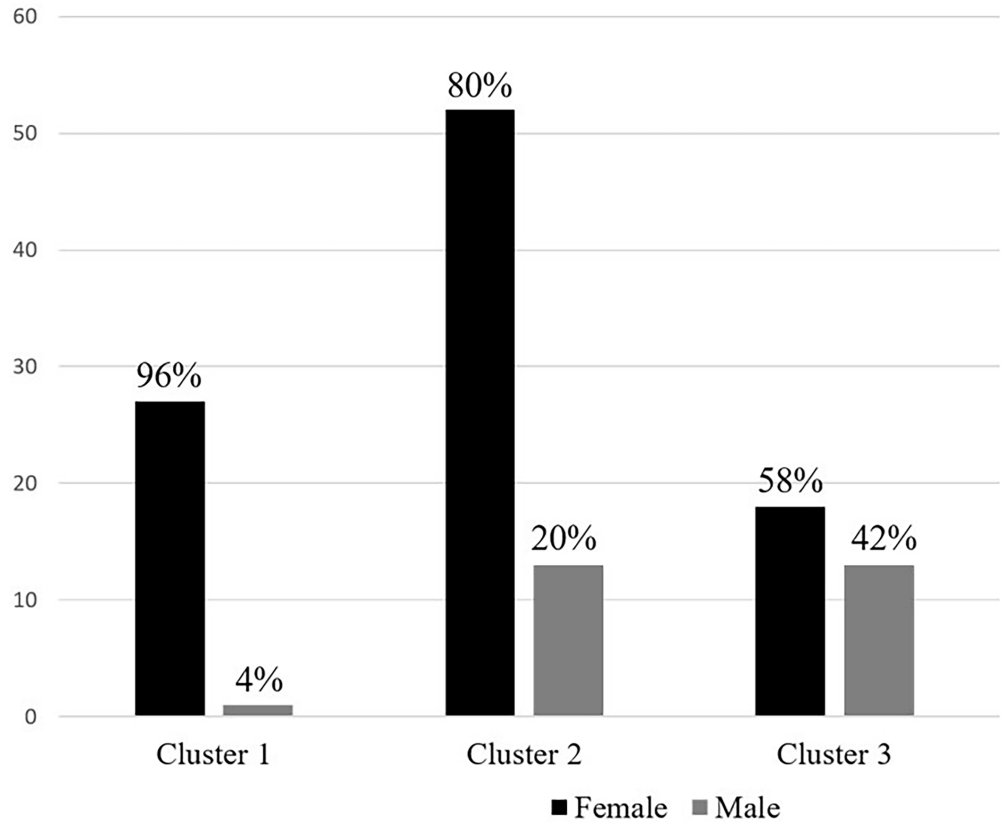

FIGURE 2
Distribution of teachers over the different technology readiness clusters.

technology as they recognize the importance and necessity of technological instruments and process, consider highly competent and in control of technological tools and devices.

Subsequently, a multivariate analysis of variance (MANOVA) was conducted to explore whether the scores of the separate variables in each of the profiles differed between the clusters. MANOVA has been selected instead of running multiple ANOVAs as a means to prevent the risk of making a Type 1 error and maintain the relationship between the variables (Field, 2013). The Wilks' Lambda was revealed to be significant highlighting the differences between the clusters, [$F(2,119) = 19.54$, $p < 0.001$, partial $\eta^2 = 0.25$]. Finally, chi-square tests of association were used to examined whether there was a relationship between the profiles and the demographic variables. Such analyses showed no significant association between teacher profile, age, and teaching experience. However, the analyses did reveal significant results for the relationship between profile and gender, χ^2 (2) = 12.97, $p < 0.01$. When observing in detail the distribution of teachers across the profiles (Figure 2), it is possible to observe that both clusters 1 and 2 are mainly represented by female teachers, whereas profile 2 appears to be balanced.

Comparison of the teacher technology readiness profiles and their emotional state

In order to investigate whether teachers' emotional state during ERT (in the context of COVID-19) differs among the groups, two one-way ANOVAs with cluster membership as the independent variable and PA and NA as dependent variables were performed. Table 2 shows the ANOVA results. With respect to teachers' NA, no significant differences between the clusters were revealed. However, significant differences were found for teachers' PA, [$F(2,121) = 10.65$, $p < 0.001$, $\eta^2 = 0.15$]. In detail, *post hoc* tests showed that cluster 3 ($M = 4.21$; SD = 0.90) varies significantly different to cluster 1 ($M = 3.20$; SD = 0.81) and 2 ($M = 3.52$; SD = 0.88) with regards to their PA during emergency remote teaching ($p < 0.01$). In contrast, cluster 1 and 2 did not varied significantly among each other. Considering the distinctive characteristics and features of each cluster (please refer to the previous section for a detailed description of the teacher clusters), it can be assumed that a positive emotional state does not solely rely on teachers perceiving themselves either technologically competent, acceptant of technology, or having higher technology control beliefs; but rather a meaningful interdependent balance

TABLE 2 One-way ANOVA of the technology readiness scales between profiles.

Domain	Cluster 1		Cluster 2		Cluster 3			
	M	SD	*M*	SD	*M*	SD	*F(2,431)*	η^2
Technology acceptance	2.59	0.57	3.67	0.54	4.61	0.43	110.50**	0.65
Technology competence	3.12	0.7	4.34	0.51	4.74	0.36	77.24**	0.56
Technology control	3.21	0.46	3.63	0.48	4.6	0.33	78.58**	0.57

**$p < 0.01$.

between all three technology readiness variables, that is: teachers who are strongly acceptant of technology, considered themselves highly competent and in control of technology, experienced a far more positive emotional state during ERT.

Discussion

The COVID-19 pandemic forced teachers to rapidly shift from regular face-to-face teaching to ERT. With this unprecedent context, teachers were left to prepare teaching remotely within a short time span and with few supports. As a result, teachers faced multiple challenges leading them to experience a heavy burden, high workload, stress, and negative emotions (Klapproth et al., 2020; Portillo et al., 2020). There have been multiple studies exploring teachers' challenges and teaching practices during ERT as well as their technology competencies, readiness, and emotional states, however, there is still little research on the factors (and their interrelations) that account for the differences between teachers' experiences of ERT (Helm et al., 2021). In other words, it is still unclear how and why such shift into remote teaching was simpler for some teachers than others (Adov and Mäeots, 2021), or why some teachers were able to master the faced challenges (Klapproth et al., 2020). Against this background, the present study aimed to explore teacher profiles based on the different technology readiness domains (Neyer et al., 2012). Identifying teacher technology readiness profiles provides the opportunity to analyze in-depth the professional development and training needs that teachers require for an effective and adaptive technology use in their teaching practice. Additionally, this study sought to investigate whether teachers' emotional state varied between the teacher technology readiness profiles.

Descriptive results revealed that overall teachers perceived themselves highly acceptable, competent, and in control of technology. Such results appear to be contradictory to previous research that indicates that teachers in general feel not sufficiently competent to use technology for teaching and learning (Helm et al., 2021). However, it is important to highlight that Neyer et al.'s (2012) technology readiness scale measures an individual's general willingness and commitment toward every day technology devices, media, and tools. Thus, the results from this study indicate that teachers feel acceptant, competent and in control of regular digital situation or tools (email, PowerPoint, videoconference tools, etc.). In this context, our results are in line with the findings from Portillo et al. (2020) who reported that teachers perceived significantly competent and acceptant of common technological devices. Taken together, such findings are of importance given that they serve as a foundation for the development of digital teaching methods that are related to positive students' outcomes (Cabero-Almenara et al., 2020).

For gender, findings indicated significant differences in teachers' technology readiness, in which female participants reported lower levels of all three domains. Previous research has demonstrated considerable differences between the genders, providing evidence for example, that male teachers hold a higher technology readiness level than their female counterparts (Summak et al., 2010). Overall, empirical research in the field of ICT suggests that female participants are falling behind in terms of a wide range of variables (e.g., attitudes, self-confidence, interest, readiness and digital skills; Tømte, 2008; Ferreira, 2017). However, it is argued that such an argument can only be considered valid if male participants' ratings are used as the norm and, thus, as representative of the "expected" standard (Drent and Meelissen, 2008). In this sense, Ferreira (2017) discusses that these differences might stem from deep-rooted gender stereotypes and preconceived ideas of how women and men use (or should use) technology. Consequently, the statistically significant gender differences within this study does not automatically imply that female participants are falling behind the male sample. When taking a closer look at the study's results, it can be observed that the total mean score for the sample's technology readiness was significantly higher than the mean (c.f. Section "Teachers' technology readiness and emotional state"), indicating that in general both male and female participants hold higher levels of technology readiness. More specifically, in this sample, only 2% of the female participants can be considered to be at risk (given their extremely low ratings regarding their technology readiness). Taken altogether, this study calls for critical reflection on gender differences and technology readiness as well as on the evaluation of such differences.

Three distinctly characterized teacher technology readiness profiles were found. The first profile was represented by teachers scoring particularly low in technology acceptance and in average on both technology competence and control. Based on the theoretical assumptions and research on technology readiness (Neyer et al., 2012), it can be assumed although these teachers feel skillful and positive toward technology-relevant actions, they do not fully seem acceptant and willing to use technology nor consider it valuable for

everyday life. The second profile was represented by teachers scoring significantly higher in all three domains, however with a predominant higher rating for competence. For this profile it is possible to assume that teachers do perceive themselves competent in common digital instruments, devices, and actions, however do not fully consider the added-value of technology neither consider themselves to be strongly under control of their technology use outcomes. Lastly, the third profile was mainly represented by teachers scoring equivalently among the three technology readiness domains. Based on the empirical evidence (Neyer et al., 2012; Petko et al., 2018; Amhag et al., 2019; Adov and Mäeots, 2021; Woltran et al., 2022), it can be assumed that such teachers are convinced that technology is beneficial, recognize the added value of technology, consider themselves competent to use digital technology, as well as have positive control beliefs and experiences in technology-relevant situations. When comparing the three profiles based on their demographic variables of gender, teaching experience, and school track, only a significant association between technology readiness profile and gender was found. Both cluster one and two, in which teachers rated their technology acceptance, competence, and/or control significantly lower than cluster 3, were mainly characterized by a higher distribution of female teachers. Thus, clustering results from this study appears to be consistent with previous research that has reported that female teachers have lower technology competence mean values (Portillo et al., 2020), are less acceptant and hold less positive attitudes toward ICT than their male counterparts (Tondeur et al., 2016; Cain et al., 2017). Although gender differences were discussed in the earlier paragraph, it is still important to emphasize the need to actively support female teachers as well as to reflex on the fact that "the transmission of social gender roles is maintained" (Portillo et al., 2020, p. 9).

When comparing teachers' emotional states across three teacher technology readiness profiles, surprisingly, there were no differences across their negative emotional states. Thus, it can be said that the technology readiness domains did not have positively or negatively impact teachers' negative emotional state during ERT. This is an important finding because even if teachers reported significantly lower levels of technology acceptance, as in the case of cluster one, there was no association to more negative emotional experiences. On the other hand, results did indicated differences in teachers' positive emotional state when comparing the three clusters. In detail, it was revealed that teachers in cluster three had a significantly higher positive emotional state when compared to their teacher counterparts belonging to cluster one and two. In contrast, and important to emphasize is, that teachers within cluster one and two did not significantly vary among each other in terms of their positive emotional state. When comparing our results with previous research on technology readiness and emotional state (Händel et al., 2020), it seems that they draw a similar pattern. Thus, teachers who are technologically ready and willingly (cluster three) experienced a higher positive emotional state. In contrast, teachers who lack the technology acceptance, competence and control might experience less motivation, enthusiasm and calm. Taken together, the findings highlight the importance for all three technology readiness levels to be both equally high for teachers to able to experience a positive emotional state when working with technology. In other words, the sum of each of the individual technology readiness domains might not be supportive for teachers' positive emotional experiences during ERT, but rather a meaningful balance between the three domains.

Taking the findings from this study together, it is possible to identify specific areas that should be targeted in teacher development programs. First, regardless of gender, technology readiness plays an important role not only adaptive technology use, but also on their emotional experiences resulting from technology integration. Thus, teacher professional development programs should foster not only educators' technology competence, but also their acceptance and control for technology by promoting and providing them means to learn how to meaningfully and productively make use of technology and digital instruments. Second, teacher professional development can strategically target the needs of the specific clusters. For instance, cluster one and two should have a special focus on fostering and developing their attitudes and control beliefs through action-oriented courses that would allow them to test technology in their teaching situations. Such experiences would also provide them the opportunities to reflect and evaluate whether and how technology benefitted or improved their teaching practice. On the other hand, teachers in cluster three, could be provided with advanced and specialized courses on new technology innovations for schools. They could also serve as mentors and role models for their colleagues in cluster one and two, and can be also given the opportunity of working together to develop new technology enhanced formats with their teacher colleagues and school staff.

Additionally, the findings from this study also point out at the important role that teacher education has on pre-service teachers' future performance and successful mastery of new challenges. In particular, results emphasis the need to foster the development of pre-service teachers' technology-related competencies, attitudes, and beliefs. This can be done by allowing pre-service teachers they to observe technology integration during their teaching internships and collaborate with their peers in authentic scenarios (Tondeur et al., 2012). Moreover, pre-service teachers should also be encouraged to design lesson plans incorporating technology as a teaching instrument, to pilot such lesson plans, and to implement them in the classroom. Lastly, schools and universities should partner up to enable pre-service teachers to work together with in-service teachers in real "teaching" situations (Hobbs, 2011; Tondeur et al., 2018).

Limitations and further research

It is necessary to acknowledge several limitations. First, the present study used convenient sampling, which is a common research strategy that possesses great advantages (e.g., least time-intensive and simple to conduct). However, it also carries important disadvantages. One of these is that the results obtained from such samples have generality only to the sample under study (Bornstein

et al., 2013). Additionally, teachers in special education and vocational schools, as well as other school tracks are underrepresented. Thus, there might be a limitation regarding the representativeness of the sample to the population. Therefore, the findings from this study must be considered with caution. In this sense, future research should not only include a larger sample but aim for a balance between school track teacher samples in order to improve the generality and transferability of the findings. A second limitation is that the present study uses teachers' self-reports. Hence, such responses can inherently be sensitive to overestimation, underestimation, or socially desired answers. A study by Desimone and Long (2010), however, revealed that teachers' self-reports regarding their teaching practices are highly correlated to classroom observations. Nonetheless, future research should not only make use of self-reports but integrate classroom observations as well.

A third important limitation is that this study holds a cross-sectional design as it only explores data from the first school shutdown. Thus, further longitudinal studies must be designed to identify how teachers' technology readiness and emotional state have evolved throughout the COVID-19 pandemic and school closures. This is in particular important given current studies indicate that due to the transition to ERT, teachers report that they have reflected in their teaching methods, are more motivated to integrate technology in their teaching (van der Spoel et al., 2020), and believe that their digital competencies have improved (Portillo et al., 2020; Adov and Mäeots, 2021). Furthermore, given that different methods of clustering analysis could yield different results (Field, 2013), it would be important for further research to test such structure in other German teachers as well as conduct qualitative interviews with participants to confirm the link between the respondents and the cluster they were ascribed to (Vanslambrouck et al., 2018). Finally, the present study did not included measures of technology use during ERT, therefore, it is not possible to explain or assume whether, for instance, teachers' technology readiness profile is associated to their technology integration (and frequency) during ERT, or whether there is any link between technology use and emotional state. Thus, future research should focus on analyzing the relations between such three factors.

Conclusion

The COVID-19 pandemic has imposed unprecedented challenges to teachers across schools worldwide, yet: "This substantial change provided us with an extraordinary opportunity to learn about the role of technology […] in a situation where teachers did not have any other option" (Adov and Mäeots, 2021, p. 1). Teachers have a key role in the effective delivery of ERT, but research has shown that there are teachers that have struggled mastering remote teaching. Consequently, teachers are suffering from stress and negative emotional experiences during the current situation. Although studies have pointed out at important factors that have helped teachers master ERT, research still the needs to fully explore how these account for the differences between teachers' experiences. The study's results should contribute to a better understanding of teachers' experiences during ERT and lead to conclusions for teacher training and professional development. However, this study also highlights the urgency for further research, as the full impact of ERT is still not fully examined.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Inspectorate and Service Directorate (Audsichts- und Diensteistungsdirektion) of state of Rhineland-Palatinate. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MP and VL-A conceived the original idea as well as planned, and carried the research project and data collection process. MP took the lead in writing the manuscript with the support from VL-A and CS who contributed to the interpretation of the results and shaped manuscript. All authors provided critical feedback to the final version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Mobile-learning adoption in teacher education amidst COVID-19: Identifying two critical stages by exploring teachers' emotions

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Mobile learning (ML) is extremely relevant to distance teaching. Although much is known about ML usage in teacher education, less is known about crucial points in teachers' ML adoption process under constraints such as the COVID-19 pandemic. The aim of this exploratory case study was to gain insight into the ML adoption process, including its critical points, by examining teachers' emotion-related language. This study investigated the emotional response of 32 inservice teachers to Mobile Learning (ML) adoption while attending ML training during the COVID-19 pandemic. The data were collected using semi-structured interviews (10), focus groups (3), and participants' reflections (96) at five time points. The data underwent multilevel analysis (content and linguistic analyses), revealing two critical stages during the ML adoption process and indicating several factors that may affect the quality of emotional response, thereby promoting or impeding this process. The study highlights the critical sages and their related features that must be addressed to promote optimal ML adoption in teacher education in both routine and emergency conditions.

KEYWORDS

mobile-learning, teacher education, COVID-19, emotional response, linguistic analysis

Introduction

The importance of encouraging teachers to acquire technopedagogical skills was recognized before the outbreak of the COVID-19 pandemic (Voithofer and Nelson, 2021). Preparing teachers to use technology effectively (Carrillo and Flores, 2020; Lin and Johnson, 2021; Frei-Landau and Avidov-Ungar, 2022) was considered an aspect of teachers' professional development in the digital age (Tsybulsky and Levin, 2019; Avidov-Ungar and Tsybulsky, 2021; Tsybulsky and Muchnik-Rozanov, 2021). The outbreak of the pandemic

has made the transition to distance learning even more urgent, prompting scholars and practitioners to investigate and explicate the processes involved in the adoption and implementation of technology-based teaching, especially in the field of teacher education (Frei-Landau et al., 2022).

The use of digital mobile learning[1] (ML), which involves the use of mobile devices, has become increasingly popular (Giannakas et al., 2018; Mahdi, 2018; Zilka, 2019; Özhan and Kocadere, 2020; Xodabande et al., 2022) because of its unique advantages in remote teaching, which include ease of access and affordability. This study aimed to expand our understanding of the ML-adoption process by inservice teachers during the COVID-19 pandemic, by analyzing their emotion-related language. In particular, we sought to explore inservice teachers' emotional response to adopting ML and identify the factors that affect the quality of emotional responses and thereby either promote or impede this process.

Literature review

Mobile learning in teacher education

Mobile learning involves the use of mobile computing devices, as an integral component of teaching and learning processes (Grant, 2019; Zilka, 2019; Mohammadi et al., 2020). Through the enrichment of learning environments with multimedia content (Becker et al., 2020), ML provides a varied learning experience (Park et al., 2018), which improves learners' academic outcomes (Chen et al., 2020; Mitra and Gupta, 2020) and increases their motivation, learning efficacy (Blau, 2019), and learning involvement (Hatun Ataş and Delialioğlu, 2018). Several theoretical frameworks of ML usage have been proposed (Okai-Ugbaje, 2021), among them, "Mobagogy, "which emphasizes the pedagogical benefits of ML implementation in education (Schuck et al., 2013), as well as social collaborative learning (Danish and Hmelo-Silver, 2020), Self-regulated learning (Kramarski and Heaysman, 2021), and self-determination theory (Yang et al., 2019).

The advantages of ML adoption have been well-established, such as its reliance on the highly pervasive smartphone technology, which can help reduce social gaps and inequality in learning (Ilgaz, 2021; Frei-Landau and Avidov-Ungar, 2022), and the ability to adjust and monitor learning through digital applications, which creates a more personalized learning experience (Nedungadi and Raman, 2012); thus, suits different learning styles. These benefits were even more significant when distance learning became a necessity (Eutsler, 2021) during the COVID-19 crisis, resulting in the need to minimize the impact of socioeconomic status and guarantee equitable access to education (UNESCO, 2020; Grogan et al., 2022). However, ML offers a universal form of learning (Aljawarneh, 2020) that can be applied not only in future emergencies but also routinely, providing a solution for learners who are unable to attend face-to-face meetings, even when they cannot gain access to a computer.

Previous studies mostly examined the use of ML in routine times (Lai, 2020), and less than one-third of the existing studies focused on teachers (Baran, 2014). Furthermore, in the majority of studies, the focus was either on identifying aspects that promote or inhibit ML adoption (Moya and Camacho, 2021), participants' perceptions and attitudes toward ML (Gikas and Grant, 2013), or their intention to adopt ML (Buabeng-Andoh, 2021). However, we have yet to fully understand the critical stages within the process of ML adoption and implementation in teaching (Lai, 2020). This study aims to fill this gap by exploring teachers' emotions to identify such critical stages.

Teacher emotions and technology adoption

Awareness of teachers' emotions is crucial for understanding teaching and teachers (Zembylas, 2003; Korthagen and Vasalos, 2005). In particular, understanding teachers' emotions associated with the processes of adopting and implementing technology-based teaching is vital given that emotions tend to affect teachers' beliefs regarding acquiring certain technopedagogical skills (Bandura, 1986). Moreover, it is often teachers' emotional response to technology that defines their ability to design creative, technology-rich practices (Azzaro and Martínez Agudo, 2018). Few recent studies showed how examining the emotional response evoked along the process of technology adoption can contribute to understanding technology acceptance (Meishar-Tal and Levenberg, 2021). For instance, Holzmann et al. (2020) suggested that high levels of nervousness or discomfort related to using a technology negatively affected teachers' intention to implement it. According to Straub (2009), since a technology change tends to evoke a particular emotional response, encouraging technology adoption means accepting the possibility of a negative emotional response. Overall, the existing research on emotional aspects of technology adoption and the way in which certain teachers' emotional responses may affect the acceptance of technology is relatively limited and deals mainly with the feelings of either satisfaction or tediousness experienced when learning in an online setting (Stein and Wanstreet, 2015; Meishar-Tal and Levenberg, 2021; Togaibayeva et al., 2022).

Studies conducted in the higher education context have suggested that teachers' negative emotional response to the adoption of the latest technology tends to lead to technology's anxiety, thereby affecting teachers' adoption of mobile learning (Mac Callum et al., 2014; Dolawattha et al., 2019; Torres, 2022). Bennett (2014) studied lecturers' emotions associated with integrating new technology into their teaching practices. Although a range of positive emotions was documented, these did not

1 Mobile learning, hereafter: ML; INTW- Interviews. FG- Focus Group.

outnumber the negative emotions, such as anxiety, fear, humiliation, and anger. However, to the best of our knowledge, no study has explored the emotional response of teachers to the process of ML adoption during the COVID-19 pandemic, so this work seeks to expand our understanding of this process by analyzing the participants' emotion-related language to gain an understanding of the critical stages in teachers' ML adoption.

This study employs the broaden–and–build theory of positive emotions proposed by Fredrickson (2004) to conceptualize the role of positive emotional experiences in the ML-adoption process during the COVID-19 pandemic. According to Fredrickson's theory, positive emotions can broaden one's awareness and encourage novelty in thinking and actions even in the face of challenges, thus advancing the building one's skills and personal resources (Fredrickson, 2001). Moreover, according to the theory, positive emotional experiences create "efficient antidotes for the lingering effects of negative emotions" (Fredrickson, 2000, p. 8).

In the realm of education, the broaden–and–build theory has been employed to explore the role of positive emotions in second language learning, demonstrating the profound effects that positive emotions have on language learners' motivation, learning, and achievements (Rahimi and Bigdeli, 2014). Another study employing the broaden–and–build theory postulated the impact of positive emotions on teenagers' engagement in learning at school (Reschly et al., 2008). In higher education context, the broaden–and–build theory has been employed to explore the effects of gratitude intervention on students' problem solving, anxiety, and psychological well-being (Lee and Chen, 2009), as well as on teachers' teaching satisfaction (Nalipay et al., 2019). In a more recent study, Sriwidharmanely et al. (2021) suggested that the broaden–and–build theory helps alleviate the negative effects of technostress on technology users' performance. However, to the best of our knowledge, the broaden–and–build theory has not been employed to study emotional aspects of the ML-adoption process, especially during the COVID-19 pandemic. The current study applies the broaden–and–build theory to understand the critical learning stages in the ML-adoption process during the COVID-19 pandemic, by exploring teachers' emotional response to it and using two complementary analytic methodologies: linguistic and content analysis. The linguistic analysis helped examine language choices manifested throughout the reflective reports, focus group, and interview data (Trent, 2013; Schieble et al., 2015) made it possible to identify implicitly conveyed messages, while the content analysis served to organize and understand the explicitly conveyed perceptions (Muchnik-Rozanov and Tsybulsky, 2019). Thus, the combination of these two methods provided comprehensive answers to our research questions.

Following Venkatesh et al. (2003), we defined emotional response to the ML-adoption process as individuals' overall affective reaction (represented in their emotion-related language) to their exposure to and hands-on practice and implementation of ML technology during the training period. Therefore, the research questions were composed as follows:

How did teachers' emotional response to their experience of ML adoption during the COVID-19 pandemic manifest in their emotion-related language, throughout the different stages?

Based on the teachers' emotion-related language, which factors are related to the quality of emotional response, and therefore may be perceived as either promoting or impeding the ML-adoption process?

Materials and methods

The study context: The ML training workshop

The ML training workshop is a short-term five-stage program, designed in accordance with Rogers' Diffusion of Innovation Theory (Rogers, 2003) that addresses knowledge, persuasion, decision, implementation, and confirmation. Figure 1 describes the training stages in light of this theory and shows the data collection points. The workshop was held at an academic teacher education college and was attended by experienced teachers. During this training program, the teachers were first introduced to five ML tools and used them as learners. Then they selected a specific tool from among the five and implemented it while teaching their peers. Finally, they used this tool as schoolteachers conducting an ML-based lesson plan. Each of these phases was accompanied by individual and group reflection processes.

The study design, participants, and data collection

Given that the goal of this study was to understand participants' perceptions of the ML workshop experience, a qualitative approach was deemed most suitable. Employing an exploratory case study design (Yin, 2014) complemented by the use of multiple data sources throughout the five-stage ML-adoption process, afforded us an in-depth view of the explored phenomenon.

Of the 45 teachers enrolled in the ML workshop that was conducted as part of the Master of Education program, 32 gave their informed consent to participate in the study. We chose teachers, as opposed to preservice teachers, considering that the professional literature indicates that at this stage of their career, teachers are more likely to be ready to incorporate technology use into their routine teaching (Russell et al., 2003). The participants taught in kindergarten (28%), elementary school (56%), middle school (6%), and high school (10%) (Participants demographics are presented in Table 1).

The reliance on multiple data sources and different modalities for eliciting the data not only ensured our ability to attain an in-depth understanding of the phenomenon (Bogdan and Biklen,

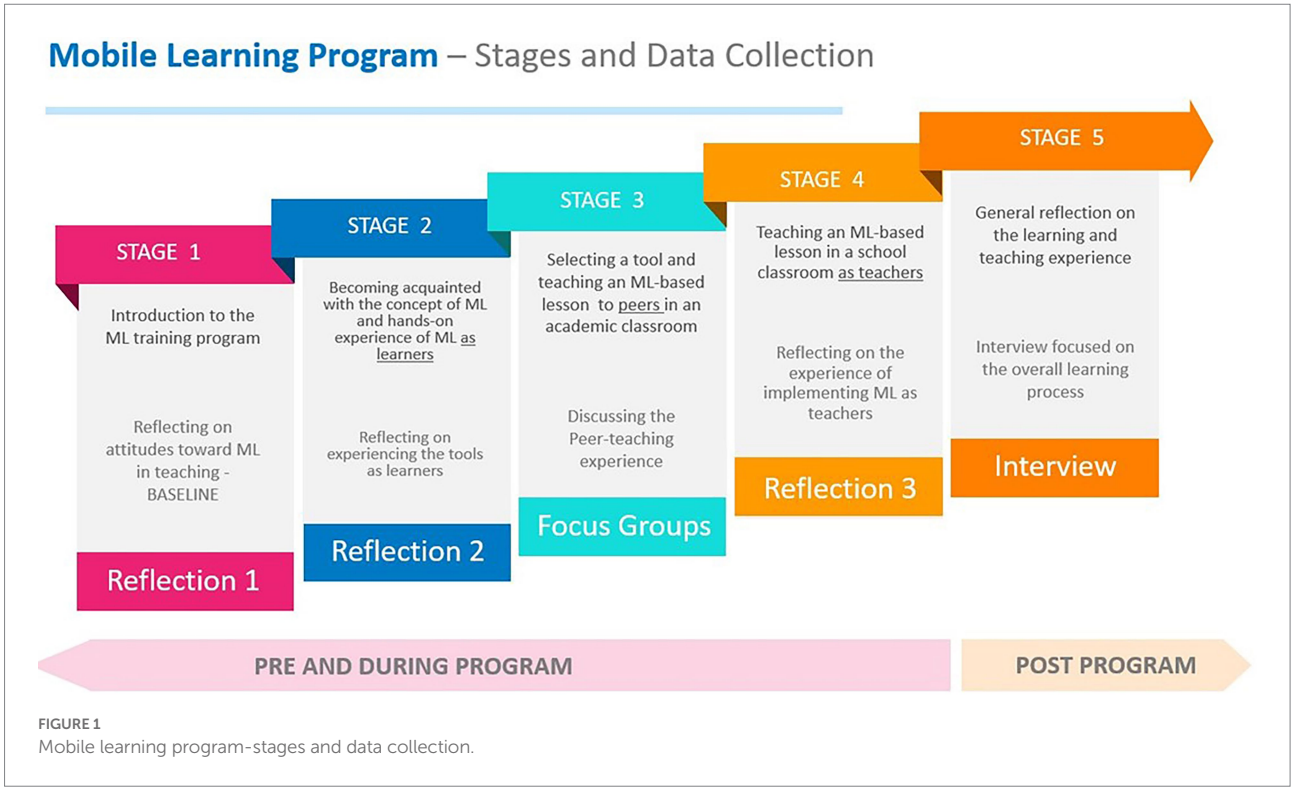

FIGURE 1
Mobile learning program-stages and data collection.

TABLE 1 Inservice teachers' demographic characteristics.

Background variables		Frequency in percentages ($N = 32$)
Gender	Male	3%
	Female	97%
Age	21–30	9%
	31–40	38%
	41–50	53%
Years of teaching	1–5	6%
experience	6–10	22%
	11–15	34%
	16–20	25%
	>20	13%
Family status	Single	13%
	Married	65%
	Divorced	22%
Type of teacher	Kindergarten	28%
	Elementary school	56%
	Middle school	6%
	High school	10%

1998) but also enhanced the study's trustworthiness, and facilitated cross-validity checks:

We collected *written reflections from the participants* at three time-points throughout the training. The instructions for preparing the reflections were to freely elaborate about their experiences, feelings, and thoughts, and to describe the aspects that they found most relevant. Overall, 96 teachers' reflections were reviewed.

The three *focus groups* were held at Stage 3, after the participants had selected one of the ML tools and had implemented it in a lesson taught to their peers. Each group (consisting of 8–10 participants and lasting approximately 45 min) was told to share experiences and respond to each other's comments. The group sessions were recorded using the ZOOM platform, and then transcribed and coded.

Using the ZOOM platform, *semistructured interviews* of approximately 25–50 min were conducted individually with 10 of the participants. Each interviewee was asked to first summarize the learning experience using a metaphor and then describe the overall process. The interviews were videotaped, transcribed, and coded. A summary of data collection modalities and the collection times during the training are shown in Figure 1.

Procedure and ethics

The Ethics Committee of the higher-education institute approved the study plan. After the participants were informed about the study and were told that they could leave at will, they signed informed consent forms. Their personal information was concealed, and the files were kept in a password-protected folder to ensure participants' anonymity. The focus groups and interviews were conducted by a research assistant, so that the workshop participants would not feel pressured to participate.

Data analysis

The data were analyzed through two sequentially conducted complementary methods: linguistic and qualitative content analyses (Muchnik-Rozanov and Tsybulsky, 2019). The linguistic analysis was conducted by the first author, with a Ph.D. in Linguistics, (using AntConc software). The qualitative content analysis was conducted in two phases using Atlas.ti. Firstly, the analysis was conducted by the first and second author, with a Ph.D. in Psychology. Secondly, the third author, with a Ph.D. in Education, analyzed about 20% of the collected data. The percent agreement between the third author and authors 1 and 2 ranged from 90 to 100%. Trustworthiness was ensured by triangulating the research instruments through which the data were retrieved (i.e., interviews, focus groups, and reflections) and conducting a multilevel analysis. Furthermore, member checks were conducted to further enhance trustworthiness (Kornbluh, 2015).

Linguistic analysis

The theoretical frameworks and approaches underlying the linguistic analysis used in the present study are as follows: In accordance with Holmes et al. (2007) and Tausczik and Pennebaker (2010), speakers' or writers' "emotion words" are analyzed, to determine the extent of their emotional involvement when discussing a specific topic. Next, the valence of the emotion words is determined; to further understand participants' perceptions of various phenomena. Thus, for example, words such as "glad," "happy," and "moving" indicate participants' positive perceptions of phenomena, whereas "cruel," "hard," and "neglected" indicate a negative perception of phenomena. Thus, the study of emotion words and the valence attributed to these words provides a profile not only of participants' involvement in the educational-technological discourse but also of the quality of their emotional experiences, as these developed and shifted throughout the ML-adoption process.

We also used the Systemic Functional Linguistics (SFL) theory (Halliday, 1978) to analyze the participants' emotionally colored experiences. According to the SFL framework, certain lexical choices and patterns are linguistic indications of emotional experiences (Halliday and Matthiessen, 2004). More specifically, the use of linguistic means of intensification when reflecting on or describing emotionally colored experiences indicates a higher or lower intensity of the emotional response. Thus, intensifications may be "interpersonally neutral, "using words, such as very, much, really, completely, utterly, almost, etc., or may "derive from some interpersonally significant scale," e.g., amazingly, awfully, unbelievably, perfectly, etc. (Halliday and Matthiessen, 2004, p. 356). Intensification suggests that the experience described was particularly meaningful for the participant (Halliday, 1978; Halliday and Matthiessen, 2004; Kupferberg et al., 2013). Based on this approach, the analysis of intensification was employed to explore the aspects of an ML training workshop that were experienced as meaningful by the participating.

To summarize, the following three categories of linguistic markers were examined:

- The frequency of emotion words (indicating participants' degree of emotional immersion when discussing or reporting on their ML-adoption experience). Thus, using software AntConc of Anthony (2013) (as per Muchnik-Rozanov and Tsybulsky, 2022), we identified the emotion words. Then, to determine the participants' emotional involvement in each stage of the ML-adoption workshop, we calculated the number of emotion words in each stage of the process as a percentage of the total amount of words in that stage, and then compared the percentages per stage.
- The valence of emotion words (indicating participants' attribution of quality—positive or negative—to their emotional response regarding the ML-adoption experience). We identified the valence attributed by the participants to the emotion words they employed and calculated the percentage of positive and negative emotion words relative to the total number of emotion words used in each stage, and then compared the findings per stage.
- The presence of adverbial intensifiers (whereby, the intensity of the participants' emotional response to an experience indicates that they view that experience as particularly meaningful). To this end, we identified the experiences that were described with the use of intensifiers and interpreted these as developments that were meaningful to the participants' ML-adoption process.

Overall, 62,455 words were analyzed. The data sources (i.e., participants' reflective reports, collected at three time-points throughout the training, focus group data, and interview data) were analyzed separately. Table 2 summarizes the distinctive linguistic markers, subcategories, coding methods, and examples.

Content analysis

As a result of the previous, linguistic stage of the data analysis, we identified a change in the teachers' emotional response in Stages 2 (hand-on experience as learners) and stage 4 (implementing ML as schoolteacher). To understand why emotional changes occurred specifically in these two stages, we used a qualitative content analysis to deepen our understanding of the experiences that were indicated as meaningful during these two critical stages. These meaningful experiences were grouped into two major categories "Experiences positively affecting the quality of emotional response and thereby promoting the adoption of ML" vs. "Experiences negatively affecting the quality of emotional response and thereby impeding the adoption of ML." The qualitative content analysis was conducted in two phases, using the Atlas.ti. Firstly, the analysis was conducted by the first author, with a Ph.D. in linguistics and experience in conducting content analyses of this kind and second author, with a Ph.D. in Psychology. Reliability and validity were achieved by conducting a careful review of the stages by the two researchers. Each researcher analyzed the data separately, to the

TABLE 2 Linguistic analysis and coding method.

Distinctive linguistic marker	Subcategories	Coding method	Examples
Emotion words to measure the quality and degree of immersion in the discussed phenomenon or process	Positive	The lexemes and stems listed under the category' positive emotion words in the LIWC software dictionary (e.g., nice, confident, sincere, etc.)	"I was very happy to see that they loved the activity and were excited about it" "Nevertheless, the experience of learning in groups was a positive one; it was an experiential activity for the children"
	Negative	The lexemes and stems listed under the category 'negative emotion words' in the LIWC software dictionary (e.g., hurt, ugly, and nasty)	"I found it quite difficult and I thought this activity was too complicated for them [the students]"
Adverbial intensification	Adverbs indicating higher or lower intensity by emphasizing the quality of the experience		"Sometimes it seems overly complicated, and I just want to drop it, but at the same time, the desire to overcome difficulties [motivates me] and successfully accomplish my goals is something I find very fulfilling"

best of their knowledge, and then reported the findings in a brainstorming session, which included a discussion that focused on the research questions. In cases of disagreement, the issue was further discussed until full agreement was reached, which included all team members. Secondly, the third author, with a Ph.D. in Education, analyzed about 20% of the collected data. Percent agreement between the third author and authors 1 and 2 ranged from 90 to 100%. Regarding the qualitative content analysis.

Findings

This study examined the teachers' emotional responses during their experience of the ML-adoption process in the context of the COVID-19 pandemic. In the following section, the findings are presented in accordance with the research questions. All names used in the findings section are pseudonyms.

How did teachers' experience of the ML-adoption process during the COVID-19 pandemic manifest in their emotion-related language, throughout the different stages?

The degree of emotional immersion

The linguistic analysis of the reflective reports and the focus group data revealed certain changes in the teachers' degree of emotional immersion. Reflective reports submitted after the ISTs' familiarization with the tools and their hands-on experience of ML as learners (Stage 2) and after teaching an ML-based lesson in a school classroom as teachers (Stage 4) were characterized by a certain increase in the degree of emotional immersion (compared to the preceding stages, 1 and 3, respectively), as manifested in the greater frequency of emotion words used. By contrast, the analysis of the focus group discussions regarding the peer-teaching experience (Stage 3) revealed a decrease in the degree of emotional immersion, as manifested in the less frequent use of emotion words. Table 3 summarizes the findings regarding the degree of emotional immersion.

The valence of emotion words to measure the quality of emotional response

The analysis of the data collected at the first four stages revealed a predominantly positive valence of emotion words although both positive and negative emotion words were used. This finding pertains to our understanding of the ML-adoption process overall, as it suggests that the teachers portrayed their emotional perception of the experiences along the process as mostly positive. Additionally, two stages of the ML-adoption process were marked by a change in the ratio between positive and negative emotion words. In Stage 2, as the teachers were getting exposure to the tools and were learning to use them, there was a change in the ratio between positive and negative words (85 and 15, respectively), compared to the ratio in Stage 1 (75 and 25 respectively). Hence, Stage 2 was marked by a surge in positive emotions. The following example illustrates a teacher's positive emotional response to her experience during the exposure to ML tools, portrayed using positive emotion words and *adverbial intensifiers*: "Finally, my experience using the tools was positive and *extremely* interesting." (Keren). In the example below, Lana portrays a negative emotional response to her experience during the same stage of the ML training by employing a negative emotion word and an *adverbial intensifier*: "I found using that tool *quite* difficult" (Lana).

In Stage 3, the ratio of positive to negative emotions was the same as that found in Stage 2 (85 and 15). However, when applying the acquired knowledge to designing and teaching an ML-based lesson to school children (Stage 4), there was a relative surge in negative emotions, as the ratio of positive to negative emotion words nearly coincided with the ratio found at Stage 1 (76 and24). The following sentence, written by Hodaya, illustrates a negative emotional experience related to the stage of implementing ML technology in a classroom, which was depicted using two negative emotion words and *an adverbial intensifier*: "The Internet connection was *extremely* slow, which made the students impatient" (Hodaya). It should be noted that despite the surge in

TABLE 3 Percentage of emotion words in each stage of the ML-adoption process.

Data source emotion words	Stage 1, Reflection 1	Stage 2, Reflection 2	Stage 3, Focus Groups	Stage 4, Reflection 3
% (#)	5% (560)	11% (1,281)	7% (624)	17% (2,475)
100%: #	11,024	12,051	8,389	14,479

negative emotional experiences depicted at this stage of designing and teaching an ML-based lesson to school children, there were nevertheless some positive emotional responses, as the following example demonstrates (note the employment of positive emotion words and *an adverbial intensifier*).

> I was *very* glad that I used the iPad in the lesson. The children cooperated well, focused on the task, and progressed at their own pace. The lesson was good in terms of the experience, the learning, and the enjoyment it afforded (Dana).

Table 4 summarizes the findings regarding the valence ratios.

Based on the teachers' emotion-related language, which factors affected the quality of emotional response and therefore were perceived as promoting or impeding the ML-adoption process?

Based on the obtained findings, we wanted to understand which factors had influenced the changes in the quality of teachers' emotional response. To this end, we analyzed the use of intensification in Stages 2 (when the participants were first introduced to the tools and used them as learners) and 4 (when the participants designed and implemented an ML-based lesson plan as schoolteachers). In the analysis of Stage 2, we sought to detect factors that had possibly contributed to the increase in the number of positive emotional responses and found 106 instances of portrayals using intensification which we regarded as marking teachers' meaningful experiences. In the analysis of Stage 4, we sought to detect factors that had possibly contributed to the increase in the negative (and hence decrease in positive) emotional responses and found 130 instances of intensification. We also analyzed the data from ISTs' personal interviews (Stage 5), in which participants summarized their experiences of the ML-adoption process, and found 771 instances of portrayals using intensification, which we regarded as marking teachers' meaningful experiences.

Findings of the content analysis applied to Stage 2 of the ML-adoption process: Understanding the increase in positive emotional responses

Based on the linguistic analysis, which indicated the participants' attribution of significance to their descriptions of Stage 2 and Stage 4 experiences, we conducted a content analysis of the verbal data adjacent to emotion-related language found throughout the reflective reports collected during these stages and in the post-program interview data (Stage 5), to identify which experiences the teachers considered meaningful. Five meaningful experiences were revealed. Four of the five experiences were categorized as positively affecting the quality of emotional response and thereby promoting the adoption of ML technology. The teachers described extensive practice using the ML tools during the workshop as a catalyst for implementing ML technology into their teaching practices. In the following quote, the teachers' experience was perceived as meaningful because of the participant's use of an adverbial intensifier to describe it: "Thanks to the exposure and experience using digital tools, I began to *actually* use them in my work with students" (Adva). These findings were further substantiated in the analysis of the personal interviews. In the following quote, Haggit's use of intensification emphasizes the importance of hands-on practice in the training process: "But when I *actually* started implementing the newly acquired skills in the classroom, well… then, there is *no doubt* that it coincides with---with my—apparently suppressed—worldview" (Haggit).

Similarly, the teachers' use of adverbial intensification portrayed the exposure to innovative teaching approaches as a meaningful experience, which contributed to their positive emotional response. This positive and meaningful experience increased their motivation to implement the ML technology, as the following examples demonstrate: "It's *always* fun to learn new tools and teaching methods that integrate well with existing materials and lesson preparations" (Dana); "Overall, I *really* like the tools because they arouse students' interest and add color to the lessons. They are pedagogically useful and bring a novel freshness into the teaching" (Etti).

Another aspect of the teachers' positive emotional response to this stage of the ML-adoption process was associated with feeling curious, interested, and happy as learners during the training. The following quotes illustrate the use of adverbial intensifiers to emphasize the positive quality of the emotional response: "In summary, I'd like to note that, as a learner, these tools *really* aroused my curiosity" (Etti); "I am *very* pleased and satisfied with the process I experienced in this course" (Hodaya).

Finally, adverbial intensification was used to also highlight the positive response to experiencing the COVID-19 crisis as a catalyst for digitalization and implementation of the ML technology: "Before the first year of COVID, we had heard about the use of technology, but we did not quite understand what it could do or its many facilitative aspects" (Sarah).

Although Stage 2 was marked by a surge in teachers' positive emotional responses, experiencing difficulties and fears can be seen as a negative emotional experience that the subjects found meaningful based on its portrayal using adverbial intensification. "Nevertheless, I should mention that for me personally, any new experience makes me *really* anxious" (Lana). "I am petrified *indeed* when I have to learn to use an unfamiliar

TABLE 4 Changes in the valence ratios through the first four stages of the ML-adoption process.

Data source valence	Stage 1, Reflection 1	Stage 2, Reflection 2	Stage 3, Focus Groups	Stage 4, Reflection 3
Positive Emotion Words % (#)	75% (419)	85% (1,089)	85% (528)	76% (1,885)
Negative Emotion Words % (#)	25% (141)	15% (182)	15% (96)	24% (590)
Total = 100%	(560)	(1,281)	(624)	(2,475)

tool" (Adva). These findings were further substantiated by the analysis of the personal interviews, as the following quote demonstrates.

> To tell the truth [giggles], I had a kind of phobia…, I was really afraid of technology, and the COVID development threw me into deep waters. I would ask the other teachers to help me set up the ZOOM lesson, to upload, download…I just avoided it all, as much as possible (Sarah).

It appears that experiencing difficulties and fears during Stage 2, when the participants were first introduced to the tools and used them as learners, can be seen as the only factor that negatively affected the quality of emotional response, thereby impeding the ML-adoption process. This factor, however, was outweighed by four types of the teachers' meaningful experiences that contributed to strengthening the positive emotional response to the ML-adoption process throughout Stage 2.

Findings of the content analysis applied to Stage 4 of the ML-adoption process: Understanding the increase in negative emotional responses

The stage of applying the acquired knowledge to designing and teaching an ML-based lesson to school children (Stage 4) was marked with a certain surge in negative emotional response and a corresponding decrease in the positive emotional response. Therefore, in reviewing the data collected at Stage 4, we examined all the instances where participants employed linguistic intensification (using adverbial expressions and in one instance a superlative adjective) indicating significant experiences, to identify which factors had contributed to the change in the valence of their emotional responses. Five meaningful experiences were identified. Of these, four were described while indicating a negative emotional response, thereby impeding the adoption of ML technology, and the remaining one was described while conveying a positive effect. As noted, the positive experience associated with implementing ML technology in the classroom was outweighed by four instances of negative experiences that the teachers portrayed as meaningful while reflecting on Stage 4. The documented preponderance of the negative experiences that accounts for the surge in the participants' negative quality of emotional responses was related to the integration of ML tools into their teaching routine at school. The teachers described the perceived challenge of leaving their comfort zone as a meaningful—albeit negative--emotional experience.

> I watched the guidance videos and I tried to complete the tasks during the lesson, but I found them *very* difficult. I cannot tell if this was because I was afraid, or lacked sufficient technological knowledge, but I could not *even* seem to connect to these topics or to the idea of creating a game and thinking in a nontraditional way (Keren).

Another meaningful but negative experience that the teachers found challenging and even frustrating and which they described using adverbial intensifiers was related to the transition from theory to practice: "I found it *extremely* difficult to take it beyond the course and into the classroom where I teach" (Lana); "The initial experience was unnerving and *even* embarrassing, being in front of the parents and the kids who were looking forward to it, and I could not deliver (Shira).

Another meaningful experience that was described as evoking a negative emotional response to the ML adoption was related to the lack of resources, such as time, equipment, and a stable Internet connection while trying to implement ML technology in the classroom: "The Internet connection was extremely slow, which made the students impatient" (Hodaya); "There was an insufficient number of PCs, tablets, and mobile phones, especially among those from the socioeconomically lower class, and it became extremely difficult to include them in the lesson" (Haggit).

Finally, some teachers' meaningful experiences while implementing ML technology were related to having a conflict with the institutional policy. One of the teachers described such an experience in the interview as discouraging.

> But it also creates some upheaval in the classroom, and the Ministry of Education and the school would prefer to keep things peaceful and quiet, so the upheaval makes a bad impression. Especially, if the lesson is in a classroom located within hearing range of the principal's office and he comes in to see what the noise is all about. Well, that's already discouraging enough" (Keren).

These negative but meaningful teaching experiences, i.e., fear of leaving one's comfort zone, the difficulty in transitioning from theory to practice, the lack of resources, and the clashes with the institutional policy did more than merely evoke a negative emotional response in the teachers: the relative surge in negative emotions during this stage of ML implementation might have impeded the completion of the ML-adoption process.

However, the teachers' emotional response to teaching an ML-based lesson in class was not entirely negative. Some teachers pointed out a positive experience; specifically, implementing ML

in the classroom helped them understand the importance of digitalizing teaching practices: "I want to clarify that I enjoyed *every* single moment and, based on the feedback from the children and their enthusiastic reactions; I understood that they too enjoyed the outcome *very much*" (Etti). This positive experience was further substantiated by the interview data:

> Their [the students'] desire to participate is *truly* the best indication. Those who were absent during the lesson …went in on their own to complete the task during their free time after class–well that's *the best* feedback; they had fun (Sarah).

Similarly, in the following quote, one of the teachers explains how the experience clarified the importance of the digitalization of teaching practices.

> You're simply speaking their language and so they want to participate…how can I explain it? When students are given a worksheet, they get bored right away. But it's different when you assign questions to be answered using a colorful and attractive app (Shira).

Figure 2 summarizes the goals, process, and findings of the linguistic and content analyses.

Discussion

This study examined the teachers' emotional response throughout their experience of ML-adoption process in the context of the COVID-19 pandemic, in an attempt to identify the critical stages in ML adoption process and its related factors that facilitate or impede this process. The study highlights two critical stages in the ML adoption process in which the participants demonstrated the deepest emotional immersion: (1) after they had been introduced to and had gained extensive practice using the ML tools; and (2) after implementing the use of a particular tool to teach an ML-based lesson plan as schoolteachers. It appears that these two stages are crucial to teachers' experience of ML adoption; thus, extra attention should be given to these stages when training teachers to implement ML. Respectively, the study has both theoretical and practical contributions. Specifically, the stage of being exposed to ML as a learner, which evokes positive emotions turns out to have a crucial role in establishing teachers' adoption of ML. Additionally, the stage within which the teacher implements ML as a classroom teacher is also a sensitive stage that may affect teachers' ML adoption; thus, also requires extra attention to ensure optimal training.

Long before the COVID-19 outburst, teachers had often mentioned technology use as one of their objectives for professional development, and despite an explicit desire to acquire and master new technopedagogical skills, many found implementing these tools into their everyday teaching practices quite challenging (Louws et al., 2017). The COVID-19 pandemic magnified the need to enable teachers to use technology efficiently and confidently (Carrillo and Flores, 2020; Lin and Johnson, 2021). Recent studies on remote teaching during the pandemic crisis have indicated the need for extensive training to implement technology in teaching (Amhag et al., 2019; van der Spoel et al., 2020) and the necessity of adequate teacher training aimed at incorporating technology-based teaching practices for a successful technology adoption process (Baran, 2014; Hadar et al., 2020). Thus, detecting critical stages in this process is essential to designing such adequate training and facilitates best practice, especially in the context of distant learning under crisis as well as in routine conditions.

Deeper emotional immersion documented after implementing a particular tool to teach an ML-based lesson may indicate the magnitude of this newly acquired ability, perceived as a watershed event. On the other hand, implementing an ML tool when teaching their peers (stage 3) was accompanied by a decrease in the degree of emotional immersion. This finding can be attributed to the teachers' perception of this experience as less crucial and demanding compared to the real-time teaching challenges, which included clashes with institutional policy. Furthermore, our findings regarding the quality of teachers' emotional response expressed *via* the valence of emotion words indicated that the participants used positive and negative emotion words to reflect on the ML-adoption process. The predominance of emotion words with the positive valence was documented as reaching its peak during the phase of exposure to the tools as learners. This mainly positive valence indicates that the Teachers viewed these experiences as primarily positive, which, in turn, encourages an open and receptive attitude toward the ML training, in particular, and toward new learning and teaching experiences, in general (Fredrickson, 2001). Positive emotional perception is known to contribute to the development of new skills and personal resources, by being "an efficient antidote" (Fredrickson, 2004, p. 9) to the difficulties and challenges inherent to the process. This finding underscores the importance of teachers being exposed to ML first and foremost as learners to ensure they have experienced positive emotions and gained confidence before attempting to implement ML independently in the classroom.

Two critical shifts during the ML-adoption process

Based on the broaden–and–build theory, which underscores the quality of emotional response induced by the learning process, the analysis highlighted two critical shifts in the ML-adoption process that were characterized by a change in the emotional response: the stage of gaining hands-on experience as ML learners (Stage 2) and the stage of implementing the acquired knowledge in an ML-based lesson plan as schoolteachers (Stage 4). To clarify, given that the ratio of positive to negative emotion words did not change between Stage 2 and Stage 3, the focus of our analysis was on the positive surge in Stage 2 and the negative surge in Stage 4.

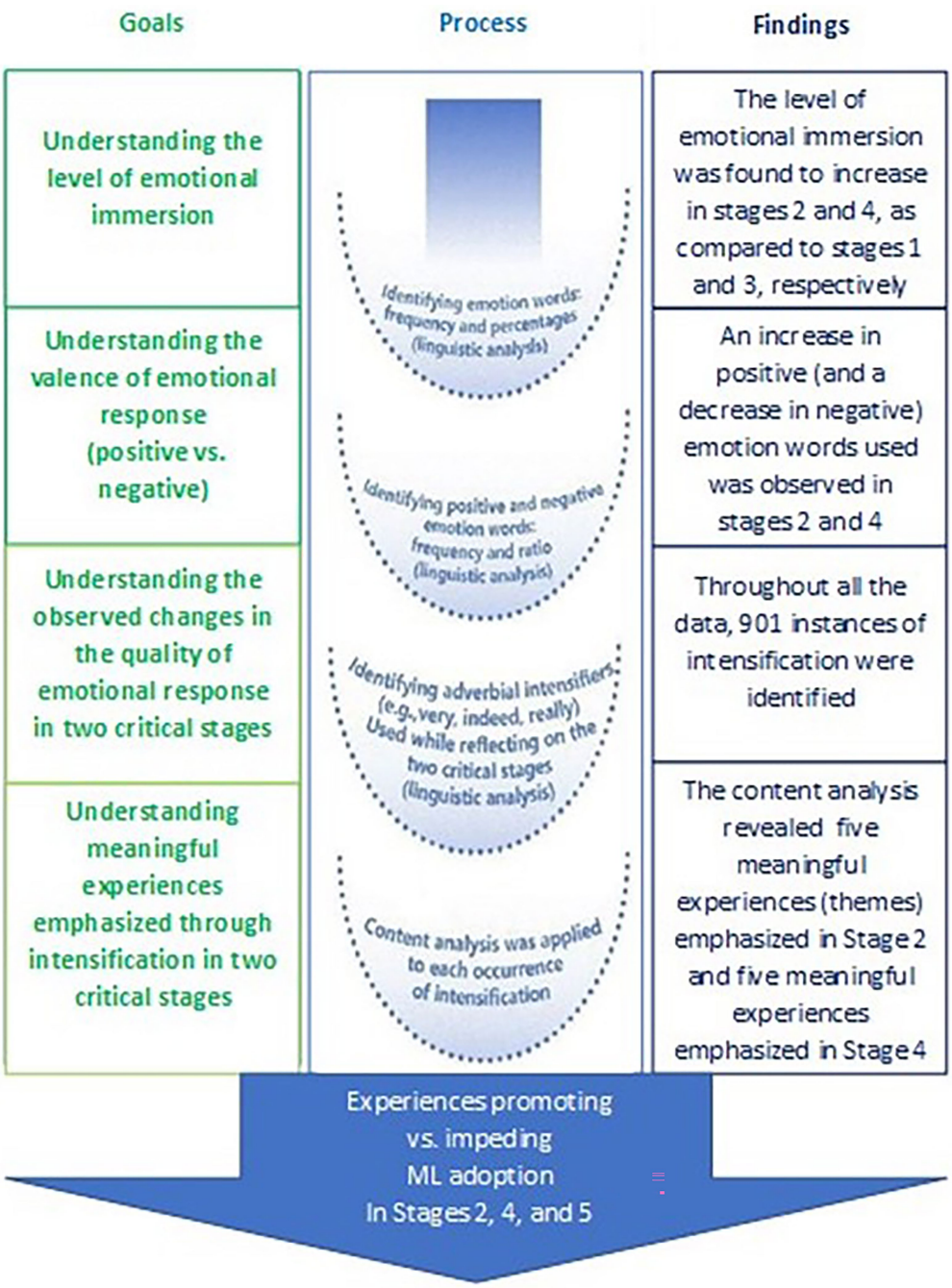

FIGURE 2
Experiences promoting vs. impeding ML adoption in Stages 2, 4, and 5.

A graphic summary of the positive and negative experiences in each of the two meaningful Stages is provided in Figure 3.

Thus, when first exposed to innovative teaching approaches and practicing them as learners, the teachers emphasized that they felt curious and happy while learning. According to Fredrickson's theory (2001), such a positive emotional response promoted the learning process and thus guided the teachers toward the goal of ML adoption. Furthermore, as the teachers reflected on the stage of familiarizing and acquiring the ML tools, they referred back to their teaching experience prior to the COVID-19 pandemic and before participating in this course. Those experiences had demonstrated the need for and motivated the participants to acquire new technopedagogical skills and overcome difficulties and fears when adopting and implementing the ML technology. The emphasized positive experiences during the initial stage of the ML training were rewarding, eye-opening learning experiences that led the teachers to comprehend the importance of school digitalization. In this regard, our findings corroborate those of

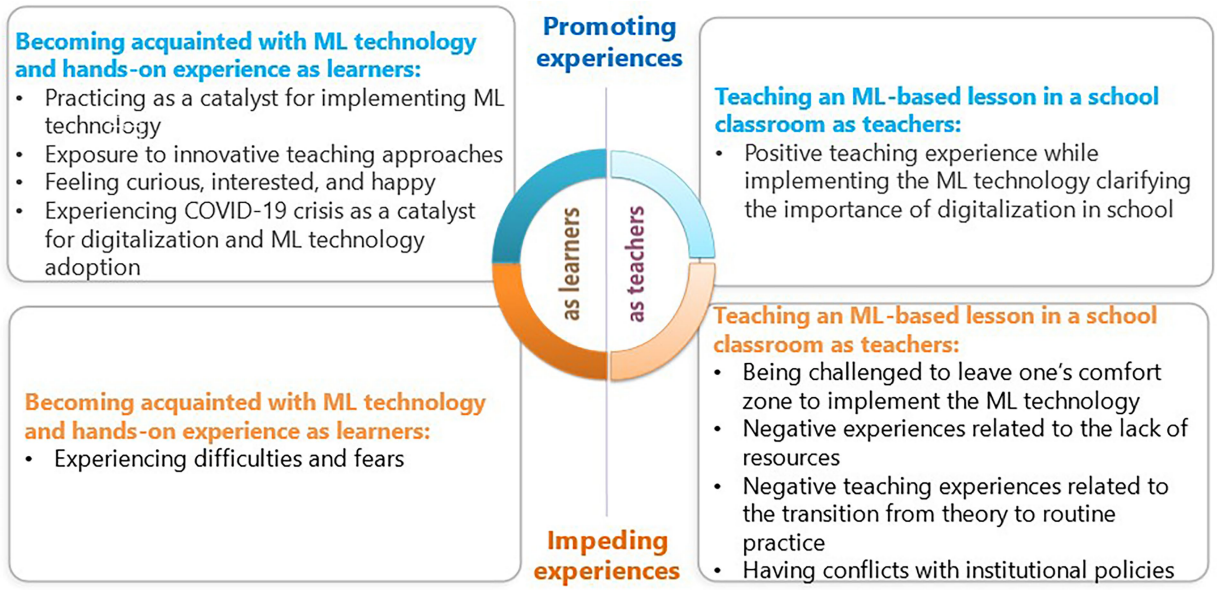

FIGURE 3
Experiences promoting vs. impeding ML adoption.

Saikat et al. (2021), who suggested that using a variety of online tools and apps can encourage learners to pay attention during the lessons, thereby making teachers' experiences more positive and rewarding. These meaningful experiences can, in turn, enhance teachers' motivation to continue implementing ML-based lesson plans, given that teachers' motivation plays a crucial role in effective technology use in schools (Backfisch et al., 2020).

However, the analysis of teachers' reflections on their implementation of ML-based lesson plans as schoolteachers revealed a decrease in the positive emotional response at that stage. Understanding the nature of this change is crucial, as it may increase the negative emotional response, which could potentially impede the process of ML adoption overall. This observation is in line with Dolawattha et al. (2019) who found negative attitudes to be among major obstacles for teachers when using technology. An observed decrease in positive emotional response and an increase in the negative indicates that the negative experiences emphasized by the teachers at that stage had a strong influence, outweighing the effect of the positive experiences. These findings corroborate Bennett (2014) who demonstrated that lecturers' positive emotions reported while integrating new technology into their teaching practices, were insufficient to outnumber a range of their negative emotions. Such negative emotional response to technology adoption can result in technology anxiety and may have a strong negative impact on the future use of technology (Mac Callum et al., 2014). The content analysis revealed that, during this phase (implementation of ML-based lesson plan), extra attention should be given to the following issues: leaving one's comfort zone, difficulties in transition from theory to practice, and the lack of resources and potential conflicts with the institutional policy. For example, participants mentioned the lack of a stable Internet connection and insufficient resources and/or preparedness, which are already known to constitute major challenges in implementing ML and other distance-learning technologies (Al-Emran, 2020). However, teacher educators involved in the process of the ML training should be aware that implementing new technologies entails extending one's efforts beyond the habitual comfort zone, an endeavor that calls for emotional exertion. Hence, attending to potential objective obstacles, such as resource availability, may be the factor that determines whether this effort becomes a positive or a negative experience.

Limitations and future research

The self-reported nature of the data can be seen as a limitation of the present study since the findings may have been affected by social desirability bias. Nevertheless, we believe that both the triangulation of data sources and the fact that the data were collected by an external research assistant helped minimize the chance of bias. Furthermore, the convenience (i.e., availability) rather than random sampling for this study can be seen as a limitation since the sample cannot be seen as representative, which calls for extreme caution while generalizing our findings. Given the increased use of ML and other distance-learning technologies, an examination of the ML-adoption process under routine conditions may further highlight the factors that tend to promote or impede ML adoption for both educators and learners in the post-COVID-19 settings. In addition, certain decontextualization of emotion words could be observed in the linguistic analysis, partially as a result of applying AntConc software. Such decontextualization should be viewed as a limitation of the present study.

We recommend conducting linguistic analysis by more than one rater and achieve high interrater reliability to minimize the instances of decontextualization and, thereby, enhance the study reliability. We further recommend comparing teachers' and students' portrayal of the ML-adoption process by comparing their descriptions in terms of language behavior. Such a comparison could identify additional aspects that may accompany the process of ML adoption in education and suggest possible challenges and coping strategies. We also recommend comparing the portrayal of the ML-adoption process by teachers of different grade levels to understand whether and in what way the process of ML adoption can be affected by this factor.

Conclusion

The current study contributes to the field in two ways. First, it contributes to the ongoing discourse regarding the ways to promote optimal ML adoption. By examining teachers' emotional response to the ML training, not only did this study point at t the significance of learners' emotions to their learning process, but it also identified two critical stages in the process of ML adoption, marked by a shift in the emotional response, thereby highlighting the factors that may promote or impede the learning process. Taking these findings into account can increase the effectiveness of future training programs dedicated to ML adoption. Second, the current work demonstrates the value of employing two complementary methodological approaches, linguistic and content analyses, in educational research. Specifically, examining the emotion-related language may serve as an indicator of critical learning phases that can ultimately guide the sequential content analysis. Given the significant findings, we may conclude that using more than one approach for the data analysis is highly promising in terms of providing a comprehensive picture of the explored educational phenomena.

Data availability statement

The datasets presented in this article are not readily available because due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is unavailable. Requests to access the datasets should be directed to Rivipsy@gmail.com.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of Achva Academic College. The patients/participants provided their written informed consent to participate in this study.

Author contributions

YM-R, RF-L, and OA-U contributed to the design and implementation of the research, the analysis of the results, and writing of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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How does online social interaction promote students' continuous learning intentions?

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Learning from online videos using synchronized Danmu comments provides a co-learning experience. To explore the factors influencing learning with or without Danmu videos, an initial set of reasons and impediments was compiled based on a pilot study of 24 Chinese university students with learning experience using Danmu videos. Three hundred such students were surveyed to determine the factors that influence their motivations and hindrances with regard to using Danmu videos. The potential predictors of users' continuance intentions were also examined. The results showed that the frequency of using Danmu videos is related to the continuous learning intention. Seeking information, social presence, and perceived entertainment motivate learners and positively impact their intention to continue learning using Danmu videos. Hindrances such as information pollution, attention failure, and visual obstacle were found to be negatively associated with learners' continuance intention in the long run. Our findings provided constructive suggestions for addressing the issue of dropout rates, and novel ideas for future studies were proposed.

KEYWORDS

Danmu videos, online learning, motivations, hindrances, continuance intention

1. Introduction

As of 2022, the rapid growth of online learning has significantly drawn the attention of researchers. Online education can be accessed in numerous ways. Researchers have examined MOOCs to explore approaches for learning on platforms such as Coursera (Young, 2012; Rossi and Gnawali, 2014; Bates, 2019). Some researchers have explored video-sharing website-assisted learning, such as YouTube (Kruse and Veblen, 2012; Tan, 2013; Buzzetto-More, 2015). Researchers have also focused on learning through social media (Mondahl and Razmerita, 2014), such as Facebook (Kabilan et al., 2010; Fewkes and McCabe, 2012; Prescott et al., 2013), Twitter (Lowe and Laffey, 2011; Rinaldo et al., 2011; Evans, 2014), and WeChat (Jin, 2018). In China, however, there is another special type of learning video, namely Danmu video, which is widely enjoyed by young people.

Previous studies have considered the features of Danmu and its impact in videos. For example, the language features of Danmu in videos have raised concerns among several linguists (Zhang and Cassany, 2019). Scholars have also focused on the impression of Chinese democracy created *via* discussions on Danmu videos (Yin and Fung, 2017) and a virtual heterotopia to oppose social norms, control, and consumerism (Gu, 2017; Chen, 2021). Computer scientists have explored motivations of Internet users to watch videos using Danmu (Chen et al., 2017). However, although learning with Danmu videos is increasingly becoming a new form of online learning, studies that determine the reasons for the enthusiastic use of Danmu videos as a learning resource are limited.

Despite the appeal of providing education with very flexible time and space boundaries, some real concerns about online learning exist. Many authors state that traditional MOOCs (Massive Open Online Courses) are not very effective due to the lack of student–teacher and student-to-student interaction; however, when opportunities for interaction and teacher responsiveness are added, the effectiveness can be improved significantly (Ma et al., 2022). Moreover, previous research has shown that high interaction rates are positively associated with students' intention to continue learning (Fang et al., 2019; Zhang et al., 2022). In Danmu, which uses a new type of commenting system, people can interact with each other during the learning process. With increased interactions, we predict that the use of Danmu will have a positive impact on the improvement of the student continuity.

In this regard, the purpose of the current study is twofold. First, we aim to explore the reasons why Danmu videos are used or not used for learning. Furthermore, as dropout rates from online learning have been a concern in the academia, we address how learning with Danmu videos can affect students' intention to continue learning online.

2. Theoretical frameworks

2.1. Danmu videos

The unique learning experience offered by Danmu videos includes the following:

2.1.1. Relative real-time interaction

In contrast to traditional commenting systems where comments are presented separately from the video content, Danmu comments work in real time while the video streams (Zhang and Cassany, 2019). During the learning process, learners can post comments based on their thoughts, feelings, questions, etc., synchronous with the video content. Compared with the separate discussion pages provided by platforms such as MOOC, Danmu can reduce the time and energy for users in taking notes, asking questions, and searching for answers in the forum later, while watching the videos.

2.1.2. "Pseudo-synchronous" learning

As observed by Johnson (2013), Danmu comments provide users with "pseudo-synchronous" co-learning experience. Participants are encouraged to discuss precise, specific, and real-time information with other learners using Danmu promptly, instead of generic impressions and *post-hoc* remarks. Learning with a large number of Danmu comments helps learners perceive the presence of others.

2.1.3. Learning with more information

Interesting and informative comments may appear when a video is viewed by a large audience. By turning on the Danmu commenting system, anyone watching the video can view the displayed information, providing the viewer with information beyond the content of the video.

2.2. Bilibili

Bilibili is one of the most popular Danmu video websites in China (Lin et al., 2018). As a comprehensive video-sharing website, users can upload, share, view, and comment on various video clips. Although originally created for entertainment purposes, Bilibili has emerged as a major platform to learn, providing a wealth of learning resources for 183 million young people studying using Bilibili. Therefore, in this study, Bilibili was selected as a case study to explore the learning behaviors of users with Danmu comments.

2.3. Social interaction in online learning

Social interaction is regarded as a fundamental way to meet social needs (Turk et al., 2022). Some existing studies have highlighted the significance of social interaction and have provided useful theoretical insights into whether and how social interaction may impact online learning (Cho and Cho, 2014; García-Peñalvo, 2014; Al-Rahmi et al., 2018). For example, Kurucay and Inan (2017) found that learner–learner interaction in an e-learning environment plays an important role in improving learning performance, and that students who interact with their peers appear to perform better than those who do not. Similarly, Molinillo et al. (2018) showed that both learner–instructor and learner–learner interactions influence learners' emotional involvement and boost their active learning. Social interaction is thought to be vital for generating critical thinking and boosting learning outcomes, because it can improve social presence and minimize feelings of isolation among learners (Zhang et al., 2017; Fang et al., 2018). Furthermore, as Cobb (2008) indicated, social interaction is highly correlated with student satisfaction and perceived learning.

Peer interaction not only allows students to have meaningful conversations with their peers and gives them opportunities to practice high order thinking skills, which can ultimately improve learning, but it also helps students feel connected to each other within the community and increases their sense of social presence. In this study, we focus on the interactions that take place during an online learning process using the Danmu commenting system. Learners can interact in real time during the video presentation and also read and interact with the comments posted by viewers who have previously watched and commented on the same Danmu video.

2.4. Continuance intention

Despite the rapid development and numerous advantages of online learning, student retention in online courses remains as something challenging to achieve, with high dropout rates causing anxiety among instructors and administrators (Chiu et al., 2005; Roca et al., 2006). Comprehensive exploration of the factors that affect students' continuance intention and how to improve it (Wu and Chen, 2017; Yang et al., 2017; Joo et al., 2018) have been carried out. Danmu, an innovative comment system, has brought about different experiences to students' learning compared to traditional learning. Can the appearance of the Danmu contribute more toward improving students' persistent intentions? This study focuses on the characteristics of Danmu and explores how the Danmu commenting system affects the continuance learning intention of learners.

In light of the above, the present study aims to explore the following research questions:

RQ1: What are the motivations for learning with Danmu videos?
RQ2: What are the hindrances for learning with Danmu videos?
RQ3: How does the Danmu commenting system influence people's continuance intention in online learning?

3. Method

3.1. Pilot study: Collection of factors influencing university students' behaviors of learning with/without Danmu videos in Bilibili

Owing to a lack of previous research, a pilot study was conducted to understand the comments and opinions of university students on Danmu videos in Bilibili. We used focus groups for data collection to facilitate the generation of different perspectives through group interactions (Krueger, 2014).

3.1.1. Participants

Twenty-four participants were recruited by sending invitations *via* WeChat. All the participants were university students and had more than 1 year of learning experience with Danmu videos in Bilibili. Based on their responses to a five-point Likert scale of Danmu video viewing frequency (every time, often, sometimes, occasionally, hardly ever) on Danmu video viewing frequency, 12 participants were classified as frequent users (learning Danmu videos every time or often in Bilibili), whereas the rest were classified as infrequent users (learning using Danmu videos occasionally, or hardly ever). To stimulate discussion from different perspectives, all the participants were divided into four focus groups, with each group consisting of three students learning with Danmu videos frequently and three infrequent users.

3.1.2. Procedure

Studies involving all the focus groups were held in Zoom calls. Before the focus group study began, the facilitator explained the purpose of the study and each participant signed an informed consent form (ensuring participant anonymity and confidentiality). Participants were then given 5 min to review their experience of learning with Danmu videos in Bilibili and complete a questionnaire about their basic information. In each focus group study lasting 50–60 min, the video and audio were recorded and retained with the permission of the participants.

3.1.3. Questions

The research team created a semi-structured question guide based on the suggested focus group methods (Krueger, 1997), aiming to identify the factors influencing university students' attitudes toward the Danmu commenting system when using Bilibili as a learning resource. Focus group discussions were initiated through opening and introductory questions, thus helping the participants to start a conversation on the topic naturally, after which a few transition and key questions were asked to lead the group to the major section of the conversation and to keep the emphasis on the study's goal, which was to discover factors that influence students' learning behaviors with or without Danmu in Bilibili. The facilitator followed an outline of questions throughout the focus group discussion to gain additional in-depth information on the topic, and a few additional questions were also asked flexibly to facilitate free discussion among the students as the following.

Opening question: Where are you from and what is your major?

Introduction: What are your reasons for using Bilibili as a learning resource?

Transition: What are your views regarding the comments posted on Danmu videos?

Key questions: Do you like learning using Danmu comments in Bilibili?

What factors motivate you to learn with Danmu comments?

What factors motivate you to turn off Danmu comments when you are learning?

What type of Danmu comments would you prefer to see?

Ending: Do you have any additional comments toward learning, with or without Danmu in Bilibili? We are exploring interactive ways and experiences of online learning, and we would be grateful for any further suggestions, if you have any.

Audios of the four sessions were fully recorded and transcribed into text format. When analyzing the data, all the members of the research team reviewed the transcripts collectively, exchanged thoughts, and discussed the key issues discovered. To form opinions about the data and ensure the reliability of the data interpretation, the members through the aforementioned stage three times. Finally, the factors were grouped into the following categories.

Motivations of learning with Danmu comments in Bilibili are as follows:

Social presence. Being able to study together online was one of the main reasons why most of the participants turned on the Danmu comments while studying in Bilibili. Online learning can be a lonely experience (Labrague et al., 2021), but Danmu provided them with a strong feeling of learning and connection with peers, thus overcoming the problem of isolation in an online learning environment.

Perceived usefulness. In the reviews, all the participants highly emphasized the value of Danmu with regard to the fact that useful information can be obtained *via* such videos. Individuals expressed the effectiveness of Danmu videos in helping them understand the learning content, especially open-minded content. "The views of others expressed through Danmu always bring me inspiration." In addition, they mentioned that if learners encounter difficulties when learning, they can always ask questions in Danmu and will usually always receive a reply.

Perceived enjoyment. Learning is a boring process; however, a significant amount of interesting content is shown in Danmu reviews, which stimulates participants' interest in learning; this makes them more willing to turn on Danmu and enjoy the fun of learning in Bilibili.

Reasons for learning without Danmu comments in Bilibili are as follows:

Distracted attention. The majority of the participants highlighted that Danmu comments were a distraction during learning, and they therefore turned them off. Danmu comments can sometimes contain irrelevant, repetitive, and low-value information (e.g., negative personal emotions and disagreement statements between learners in terms of differing opinions or ideas). Therefore, students' attention can easily be drawn to such information, which may, in turn, reduce the effectiveness of online learning.

Visual obstacle experience. The fonts and colors of the Danmu comments were perceived as unattractive by some participants. In terms of viewing experience, some participants mentioned that the Danmu comments ruined the esthetic feel of the learning platform and even obscured the content of the original video; this was found to be very distracting by the aforementioned participants.

3.2. Survey: Identification of the factors affecting learning with Danmu in Bilibili

3.2.1. Participants

The participants in this study were university students who had learned from Danmu videos in Bilibili. For data collection, we conducted an online survey for this study using a professional research panel provided by Credamo (a well-known online questionnaire company in China). Three hundred valid questionnaires were collected from Chinese university students who had experienced learning using Danmu videos in Bilibili. All participants filled out an informed consent form. The demographic information of the participants is presented in Table 1.

TABLE 1 Demographic statistics of participants (*N*=300).

Measures	Items	Frequency	Percentage (%)
Gender	Male	90	30
	Female	210	70
Educational level	Undergraduate	250	83.3
	Graduate	50	16.7
Discipline	Social science and humanities	158	52.7
	Natural science	142	47.3
Frequency of learning with Danmu videos	Always	52	17.3
	Often	117	39
	Sometimes	55	18.3
	Occasionally	62	20.7
	Hardly ever	14	4.7

3.2.2. Instruments

The questionnaire was divided into four parts. In Part 1, we collected demographic information (i.e., gender, educational level, and discipline) and asked questions related to the frequency of learning with Danmu videos in Bilibili. Parts 2 and 3 were about the factors influencing learning with Danmu videos. Part 4 was designed to examine the students' continuous intention to learn using Danmu videos. The items used for the measurement of continuous learning intention were extracted and modified from Fu et al. (2020).

All items in part 2,3,4 was scored on a 5-point Likert scale (Joshi et al., 2015). To remove the language barrier, the questionnaire was translated into Chinese by professional translators and checked by two native Chinese speakers to ensure that the content was comprehensible and free from ambiguity. Then, the draft questionnaire was pilot tested with 15 students from different universities who learned using Danmu videos in Bilibili. Some items were modified according to their suggestions.

4. Result

4.1. Descriptive analysis of gratifications, hindrances, and continuous intention of learning with Danmu videos

As shown in Table 2, when comparing the reasons for studying with Danmu videos, students reported higher levels of social presence (Mean = 3.98, SD = 0.63), followed by gaining useful information through Danmu (Mean = 3.90, SD = 0.82). Finally, there is the perceived interestingness that comes with Danmu (Mean = 3.79, SD = 0.71).

TABLE 2 Factors of gratifications of learning using Danmu videos.

Factors	Items	Mean	Standard deviation
Perceived usefulness	Danmu brings me useful information	3.89	0.95
	Danmu helps me to access information effectively	4.25	0.79
	Danmu gives me more inspiration	3.96	0.83
	Danmu helps me to better understand the content of the learning videos	3.95	0.89
	Sometimes the content of Danmu helps to answer my questions	3.92	0.9
	Mean = 3.79, SD = 0.71		
Perceived entertainment	Danmu is funny	3.94	0.99
	Danmu makes me feel relaxed	3.85	0.96
	Danmu makes learning more fun	3.92	0.92
	Danmu brings me joy even when the content of the learning videos is boring	3.89	0.95
	Mean = 3.9, SD = 0.82		
Social presence	Danmu makes me feel like a member of a learning community	3.88	0.84
	Danmu makes me think I am studying with my classmates	4.25	0.79
	When my thoughts are consistent with the Danmu, it gives me a sense of resonance	3.96	0.83
	Danmu creates an atmosphere and opportunity for me to interact and communicate with other learners	3.89	0.78
	Danmu reduces my feelings of isolation	3.95	0.89
	Danmu gives me a sense of companionship when I study	3.92	0.9
	Mean = 3.98, SD = 0.63		

TABLE 3 Hindrance factors in learning with Danmu videos.

Factors	Items	Mean	Standard deviation
Attention failure	Danmu diverts myself from the watching experience of the original video	3.53	1.09
	Danmu distracts me from my studies	3.18	1.12
	Danmu is not conducive to me being fully engaged when I study	2.79	1.06
	It is difficult for me to engage in my work when my views are not in line with those in Danmu	2.88	1.12
	I am easily distracted from my study time by Danmu	3.3	1.14
	Mean = 3.13, SD = 0.91		
Visual obstacle	The format of Danmu is unattractive	2.71	0.9
	Danmu obscures the content of the original video	2.91	1.13
	The colorfulness Danmu is unattractive	3.36	1.12
	Mean = 3, SD = 0.93		
Information pollution	There is information in Danmu that is not relevant to learning	3.94	0.85
	There are repetitive messages in Danmu	4.21	0.75
	There are emotional messages in Danmu	3.68	1.01
	There are negative messages in Danmu	3.47	1.04
	There is no valuable information in Danmu	3.85	0.92
	Mean = 3.83, SD = 0.75		

TABLE 4 Continuous learning intention.

Factors	Items	Mean	Standard deviation
Continuous learning intention (Fu et al., 2020)	In the future, I will continue to use Danmu videos for learning	3.61	0.942
	I will recommend learning using Danmu videos to others	3.58	1.111
	I will open Danmu comments as I learn	3.72	0.975
	I will continue to interact and communicate with other learners in Danmu	3.44	1.094
	I would be happy to use Danmu videos in my future studies	3.29	1.1
	Mean = 3.53, SD = 0.92		
	Cronbach's alpha = 0.92		

TABLE 5 Kaiser–Meyer–Olkin test (KMO) and Bartlett's test.

Kaiser–Meyer–Olkin measure of sampling adequacy		0.943
Bartlett's test of sphericity	Approx. Chi-square	4970.513
	Df (no. of degrees of freedom)	325
	p-value (Sig.)	0

As shown in Table 3, information pollution, which addresses issues of spam in Danmu (repetitive, negative, emotional discharge, not relevant, no value messages) ranked first (Mean = 3.83, SD = 0.75). Attention failure ranked second (Mean = 3.13, SD = 0.91). Visual obstacle (Mean = 3.00, SD = 0.93) ranked last.

As shown in Table 4, students express a high intention to continuously learn with Danmu videos (Mean = 3.53, SD = 0.92). The Cronbach's alpha was 0.92, which meets the recommendation level (Tavakol and Dennick, 2011).

4.2. Reliability and validity tests

A principal component factor analysis with varimax rotation was conducted on the 28 items to check the validity of measurements and determine whether the key dimensions of motivation and hindrance in learning with Danmu videos were consistent with the focus group results.

Table 5 shows the Kaiser–Meyer–Olkin test (KMO) and Bartlett's test results. As shown in Table 5, the KMO value was more than 0.5, and the Bartlett's test was significant ($p < 0.001$). The validity test of the questionnaire is satisfactory (Tabachnick et al., 2007).

Table 6 shows the rotated component matrix. In line with the focus group results, a total of six factors were generated. Items with a factor loading of above 0.3 can be retained. However, social presence1, social presence5, and social presence6 were removed owing to cross loading (Goni et al., 2020). In total, the six components generated accounted for 70.31% of the total variance, indicating that the model was a good fit (Montoya and Edwards, 2021).

For the reliability test, a value of Cronbach's alpha above 0.7 is considered to have very good internal consistency (Tavakol and Dennick, 2011). The reliability of these factors was accepted, with Cronbach's alpha values ranging from 0.76 to 0.88 (Table 7).

4.3. Continuance intention of learning with Danmu videos

Regression analyses were conducted to explore the factors influencing students' intention to continue learning from Danmu

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TABLE 6 Rotated component matrix.

	1	2	3	4	5	6
Information seeking1	0.751					
Information seeking2	0.735					
Information seeking3	0.567					
Information seeking4	0.685					
Information seeking5	0.559					
Perceived entertainment1		0.711				
Perceived entertainment2		0.722				
Perceived entertainment3		0.664				
Perceived entertainment4		0.665				
Social presence1						
Social presence2			0.558			
Social presence3			0.713			
Social presence4			0.765			
Social presence5						
Social presence6						
Information pollution1				0.742		
Information pollution2				0.686		
Information pollution3				0.813		
Information pollution4				0.795		
Information pollution5				0.755		
Visual obstacle1					0.633	
Visual obstacle2					0.738	
Visual obstacle3					0.686	
Attention failure1						0.597
Attention failure2						0.609
Attention failure3						0.788
Attention failure4						0.704
Attention failure5						0.764

TABLE 7 Cronbach's alpha test results.

Factors	Cronbach's alpha
Information seeking	0.87
Perceived entertainment	0.88
Social presence	0.76
Information pollution	0.87
Visual obstacle	0.87
Attention failure	0.88

videos. Preliminary operations were performed to confirm the assumptions of independence, singularity, and multicollinearity (all variance inflation factors were <4). In both regression analyses, demographic differences, such as gender, educational level, grade, age, discipline, and use frequency, were entered first to control for the possible influence of these factors. The factors contained in motivations and hindrances were then analyzed. The results are presented in Table 8.

In terms of demographic differences, as the value of p-values corresponding to gender ($p = 0.326$), education level ($p = 0.906$), grade ($p = 0.722$), age ($p = 0.126$), and discipline ($p = 0.497$) were all greater than 0.05, there is no significant effect on sustained intention to learn using Danmu videos. However, as the value of p is much smaller ($p = 0.000$), using frequency has a significant positive influence toward the continuance intention of learning with Danmu videos.

Regarding motivations and hindrances, information seeking ($\beta = 0.342$, $p < 0.001$), perceived entertainment ($\beta = 0.20$, $p < 0.001$), and social presence ($\beta = 0.199$, $p < 0.001$) positively influence students' continuous learning intentions. There is a negative relationship between information pollution ($\beta = -0.116$, $p < 0.05$), virtual obstacle ($\beta = -0.1$, $p < 0.05$), attention failure ($\beta = -0.098$, $p < 0.05$), and continuous learning intentions. In total, these seven factors explain 81% of students' continuous learning intentions, which exceeds the recommended value (Cameron and Windmeijer, 1997).

To ensure that there was no multicollinearity between the variables, multicollinearity diagnosis was performed. As shown in Table 8, the VIF values were all less than 5 (Mansfield and Helms, 1982). Additionally, the residuals followed a normal distribution as shown in Figure 1. The Durbin-Watson value was around 2, which satisfies the recommended value (Farrar and Glauber, 1967). Therefore, we concluded that there was no multicollinearity between our independent variables and our findings are reliable.

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TABLE 8 Effect on the continuance intention of learning using Danmu videos.

	R square	Beta	*p*-Value	VIF	Durbin–Watson
Stage1	0.547				1.804
Gender		−0.79	0.326	1.049	
Educational level		0.016	0.906	1.941	
Grade		−0.18	0.722	2.299	
Age		0.242	0.126	1.293	
Discipline		−0.006	0.497	1.079	
Using frequency		0.739	0	1.032	
Stage2	0.811				1.967
Gender		−0.075	0.155	1.059	
Educational level		0.053	0.544	1.972	
Grade		0.021	0.529	2.357	
Age		0.085	0.405	1.305	
Discipline		−0.001	0.920	1.09	
Using frequency		0.207	0.000	2.02	
Information seeking		0.342	0.000	3.038	
Perceived entertainment		0.2	0.000	2.524	
Social presence		0.199	0.000	2.222	
Information pollution		−0.116	0.006	1.772	
Visual obstacle		−0.1	0.015	2.64	
Attention failure		−0.098	0.013	2.309	

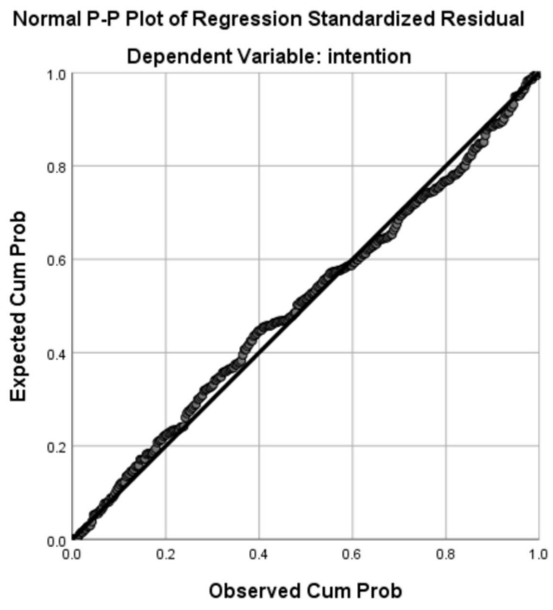

FIGURE 1
Normal distribution.

5. Discussion

Online learning platforms such as *Coursera* and *edX* provide their users with separate pages, such as discussion forums or discussion pages, to interact and communicate (Lin et al., 2018). However, the separation of learning content from commentary not only limits student interaction but also negatively affects students' sense of social presence and continued learning intentions (Wong et al., 2015). Real-time, horizontal, text-based Danmu is a product of social interaction, and it encourages students to remain engaged, interested, and committed throughout their studies. Our findings revealed that Danmu-driven social interaction provides users with advantages such as seeking additional information, perceived entertainment, and enhanced perceived social presence. All these factors are positively attributed to students' continuous learning intentions.

5.1. Demographic differences

There was no difference in the evaluation of continuance intention to learn using Danmu videos by research respondents in terms of demographic variables such as age, educational level, grade, and discipline, which is in agreement with the results of previous studies (Almahamid and Rub, 2011). However, interestingly, there is a clear positive relationship between the frequency of use of Danmu videos and the intention to learn with it consistently.

5.2. Gratifications of learning using Danmu videos

Information seeking is the strongest positive predictor of users' continuance intention to learn from Danmu videos. It is the embodiment of meeting utilitarian needs based on uses and gratification theory (Bradley, 1974). Utilitarian characteristics are also

in line with the concept of perceived usefulness in the technology acceptance model (TAM), both emphasizing practicality (Venkatesh and Bala, 2008). Perceived usefulness was positively correlated with online learning continuance intention. This is consistent with previous studies (Saadé, 2007; Chang and Tung, 2008; Lee, 2008; Tang et al., 2014). Danmu offers a unique way of seeking information and acquiring knowledge. First, Danmu helps users access information more effectively. By learning with background knowledge or answers to doubts, students can better understand the teaching content. Second, opinions expressed by others in Danmu stimulated students' thinking and inspired them. More interestingly, as the video is played more often, Danmu may provide more information. This means that over time, learners will find different and more information through Danmu.

Social presence is the second major predictor that motivates people to persistently learn using Danmu videos in Bilibili. This result is in line with previous research on the positive predictors of continuance intentions (Hayashi et al., 2004; Smith, 2006; Smith and Sivo, 2012). Online learning is a long-lasting experience. Students who study online have higher levels of loneliness than those who study in traditional classes (Gillett-Swan, 2017; Kaufmann and Vallade, 2020; Savci et al., 2022). Loneliness is a negative factor that influences online learning in various academic contexts (Vakoufari et al., 2014; Ali and Smith, 2015). However, learning synchronously with Danmu comments creates an atmosphere of companionship, thereby reducing loneliness with the increase of social presence.

Perceived entertainment is the third factor that predicts students' positive ongoing learning intentions. This is consistent with previous studies (Gao et al., 2020; Zhou et al., 2022). How to make learning more interesting has been a topic of interest for researchers. As mentioned by Jiang (2014) even if the content of the video is boring, the sense of enjoyment that Danmu brings positively influences the user's video viewing experience. Although self-learning is boring, Danmu helps learners to relax even if the learning content is boring.

5.3. Hindrances in learning using Danmu videos

Information pollution is the strongest negative predictor of continuance learning intention. Information pollution emphasizes the fact that Danmu comments contain a lot of repetitive, irrelevant, and even negative information. As cognitive load theory (Sweller, 2011) reveals, the presence of factors unrelated to learning during the learning process may place a cognitive load on the learner and thus negatively affect the learner's learning outcomes. Cognitive load has been widely demonstrated when using new media resources for learning (Krancher et al., 2019; Zheng et al., 2022), and therefore, instruction should be designed to minimize the cognitive load on learners.

Attention failure is the second negative predictor of continuance intention. The Internet has provided people with easier access to a variety of resources, including learning and entertainment. During online learning, students are likely to be drawn to other information that pops up in the Internet, which prevents them from concentrating and negatively affects their learning (Lin et al., 2022). While the Danmu commenting system provides a co-learning environment for students, there is also a lot of "noise" that distracts students from learning process.

Visual obstacles negatively affect students' ongoing learning intentions. Visual obstacles are when there are too many Danmu and the content of the video is obscured by them. Even though Danmu can be set to display position, transparency, etc., some users still perceive Danmu to be a visual obstacle.

6. Conclusion and implications

The extreme popularity of Danmu videos provided participants with a "pseudo-synchronous" learning experience. Based on a literature review, pilot study, and survey of 300 participants, this study explored the motivations, hindrances, and continuance intention of learning using Danmu videos. Our findings revealed three motivations for learning using Danmu videos: seeking additional information more easily and feeling a sense of social presence and perceived entertainment. The three major hindrances are visual obstacle, attention failures, and information pollution. Concerning continuance intention, motivations are obviously positive factors, with information seeking ranked first, followed by social interaction and entertainment. Information pollution, attention failure, and visual obstacles pose threats to participants' continuance intention. Additionally, usage frequency also contributes to students' continuous learning intention with Danmu videos.

6.1. Theoretical implications

To the best of our knowledge, this study is the first attempt to investigate the motivations, hindrances, and continuance intention of learning using Danmu videos. These results underline the special value of the Danmu commenting system in information acquisition, social presence, and perceived entertainment. In an innovative social interaction way, Danmu not only helps students better understand the video content through the provision of additional information but also makes outstanding contributions to solving the problems of social presence and perceived entertainment in online learning. In addition, from the perspective of persistent intention, motivation to learn using Danmu is also a positive predictor of continuance intention, which may provide solutions for addressing the issue of high dropout rates.

6.2. Practical implications

This study also provides practical implications for promoting students' use of Danmu videos in the learning process. Learning using Danmu videos provides the desired co-learning experience with easier information seeking and higher level of social presence and entertainment value. However, even frequent users indicate that information pollution, visual obstacle, and attention failure influence their studies to some extent. For Danmu developers, balancing the positive and negative values of Danmu has become the key to improving the role of Danmu. Furthermore, in future, Danmu is expected to be combined with more learning platforms. Therefore, more efforts should be focused on the integration of Danmu and video learning platforms, such as MOOCs, to explore its influence on continuance intention and behavioral intention.

6.3. Limitations and suggestions for future research

This research has some limitations, although it has provided insight into the continuance intent of Danmu videos in the learning process. First, the results are based only on students' opinions. Therefore, the conclusions about the effect of each observed factor are subjective. Modalities such as big data can be considered to obtain more objective research results. Second, the participants recruited in this paper cover all provinces of China, but the study does not consider the differences between provinces. Future research could consider the differences between region, ethnicity, etc. Lastly, this study only focuses on Chinese students, emphasizing the practical, social, and entertainment value of Danmu. Future research should consider whether the application of Danmu in other countries can have the same effect.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

SZ: conceptualization, research design, implementation, writing, and editing. SC: conceptualization, writing, and editing. DN: writing and editing. JK: conceptualization, research design, writing, and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Factors affecting Malaysian ESL teachers' behavioral intentions for technology use in the post-COVID-19 era

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This study aimed to investigate English as a Second Language (ESL) teachers' technology acceptance levels and to identify the factors affecting their behavioral intentions (BI) with respect to technology use in the post-COVID-19 era. A cross-sectional survey of 361 Malaysian ESL teachers was conducted. Participants were recruited *via* convenience sampling, and they answered an online survey questionnaire that was designed with reference to past studies. The collected data were analyzed *via* descriptive statistics, Pearson's correlation, and multiple regression analyses. The findings revealed that Malaysian ESL teachers generally had a high level of technology acceptance in the post-COVID-19 era. Their BIs had a significant relationship with three factors: performance expectancy (PE), effort expectancy (EE), and social influence (SI), of which EE was identified as the most significant factor influencing their BI with respect to technology use in the post-COVID-19 era. Conversely, the presence of facilitating conditions did not have a substantial connection with ESL teachers' behavioral intentions for technology use after the pandemic, despite the fact that there was weak positive relationship with each other. This study provides insights for the field of educational psychology by identifying the current trends in ESL teachers' behavioral intentions in adopting technology in the post-COVID-19-era ESL classrooms. The findings of this study may also support investigations into technology acceptance in ESL teaching, illustrating a growing need to provide adequate educational and technological tools, resources, and facilities to facilitate the delivery of lessons by ESL teachers. Future studies should conduct longitudinal research and investigate more variables from different technology acceptance models.

KEYWORDS

English as a second language, technology, behavioral intention, Malaysian ESL teachers, post-COVID-19 era, UTAUT model, education

1. Introduction

Technology continues to develop in significant ways to assist English as a Second Language (ESL) teachers in facilitating language learning for their students (Wei et al., 2023). However, the abrupt shift in the delivery mode of ESL lessons due to the emergence of the COVID-19 pandemic has resulted in widespread challenges for access to quality education, as highlighted by the fourth Sustainable Development Goal (SDG) (Rafiq et al., 2022). Accordingly, the COVID-19 pandemic forced almost all countries around the world to switch from conventional teaching methods to the alternative of fully-fledged online teaching and learning (Ye et al., 2023). Thus, the use of technology has been essential during the COVID-19 pandemic, as it was heavily relied on to provide emergency remote

teaching (ERT). Consequently, ESL teachers endeavored to learn how to use various online applications and tools to deliver effective ESL lessons and to engage their pupils in an effort to avoid learning loss (Mohtar and Yunus, 2022).

During the implementation of ERT, ESL teachers had to suddenly adopt technology to deliver ESL lessons to ensure their students' continued learning, regardless of their technological competency and acceptance level. Studies on ESL teachers' adoption of technology during the pandemic have since been conducted. For instance, Li's study (2022) on high school EFL teachers in China showed that they voluntarily learned how to integrate technology for teaching purposes. Furthermore, Wen and Tan (2020) claim that the COVID-19 pandemic served as a driving force for the adoption of technology among primary and secondary ESL teachers for ERT.

As ESL teachers conducted ERT throughout the pandemic, it has been proposed that the COVID-19 pandemic has driven teachers to demonstrate their abilities in utilizing technologies with the adoption of technological infrastructure provided to maximize the benefit of technology-based education (Choi et al., 2021). Hence, ESL teachers could utilize the technological knowledge and skills acquired from ERT to improve the quality of their ESL lessons, since mediation of technology use in these lessons could potentially contribute to desired learning outcomes (Hennessy et al., 2022). Thus, it is necessary to measure ESL teachers' technology acceptance levels in order to ensure quality education as part of the SDG (Yaccob et al., 2022), particularly in primary and secondary ESL classrooms.

The Unified Theory of Acceptance and Use of Technology (UTAUT) is one of the most comprehensive models of technology acceptance; this model was developed by Venkatesh et al. (2003). It was then revised to UTAUT-2 in 2012 to develop an overarching framework for examining technology acceptance (Venkatesh et al., 2012). The UTAUT-3 framework was later introduced as an extension of the UTAUT-2 model (Farooq et al., 2017). The UTAUT model was employed in this study because of its simplicity and understandability compared to UTAUT-2 and UTAUT-3 (Awa and Ukoha, 2020). Moreover, the UTAUT model remains a well-established and validated tool for assessing technology acceptance among users across various professions and industries (Al-zboon et al., 2021; Yang et al., 2023).

Four factors affect technology users' behavioral intentions (BI) in the UTAUT model (Venkatesh et al., 2003). Performance expectancy (PE) concerns the degree to which the technology can provide benefits and improve his or her performance to a level that is on par with expectations. Effort expectancy (EE) relates to the extent of ease of using technology. Social influence (SI) relates to the degree to which an individual perceives that it is important that others believe he or she should use the new system. Facilitating conditions (FC) represent the extent to which a technology user perceives that the existing organizational and technical support can facilitate their experience and intentions toward technology use. These four constructs have been proven to contribute to individuals' intentions toward technology use, which is relevant to this study as illustrated in Figure 1.

Nevertheless, research on changes in ESL teachers' technology acceptance levels after the COVID-19 pandemic is still deficient, leaving a gap. Therefore, ESL teachers' acceptance of technology during the COVID-19 pandemic is worth investigating to identify their intentions of using and integrating technology in their post-COVID-19 teaching and learning sessions, which will inform predictions of future educational trends and promote sustainable education aligned with the SDG (Sung et al., 2020).

Hence, this study aimed to examine ESL teachers' technology acceptance levels and factors affecting their intentions to use technology in their post-COVID-19 ESL classroom. Specifically, it sought to answer the following research questions:

1. What is the technology acceptance level of Malaysian ESL teachers in the post-COVID-19 era?
2. To what extent is there a relationship between the factors (PE, EE, SI, and FC) and Malaysian ESL teachers' behavioral intentions toward technology use in the post-COVID-19 era?
3. What is the most significant factor that influences Malaysian ESL teachers' behavioral intentions to use technology in the post-COVID-19 era?

2. Methods

2.1. Research design

This study employed a cross-sectional survey design to examine Malaysian ESL teachers' technology acceptance level and factors affecting their BI with respect to accepting the use of technology in their ESL classrooms. The UTAUT framework was used as the underlying theory of this study.

2.2. Research sample

A total of 361 ESL teachers from primary and secondary schools in Malaysia were recruited to participate in this study *via* the convenience sampling method. The participants who took part in the study fulfilled the pre-requisite of working in either a primary or a secondary school in Malaysia and having experienced ERT during the COVID-19 pandemic. This ensured that only eligible respondents answered the questionnaire to achieve this study's objectives (Andrade, 2020). Overall, 61 male (16.9%) and 300 female (83.1%) ESL teachers located all over Malaysia participated in this study. Most of them were 31–40 years old (37.7%), held a bachelor's degree (76.5%) in Teaching of English as a Second Language (TESL) (62.6%), and had up to 10 years of English teaching experience (66.8%) at a government primary school (81.2%) located in an urban area (46.5%) (Supplementary Table 1).

2.3. Research instrument

The cross-sectional survey method of data collection was employed. There were 20 items in the devised survey questionnaire based on the main five constructs of the UTAUT model, namely PE, EE, SI, FC, and BI, with reference to the relevant literature (Thompson et al., 1991; Huang et al., 2021; Mohammad-Salehi et al., 2021; Yunus et al., 2021;

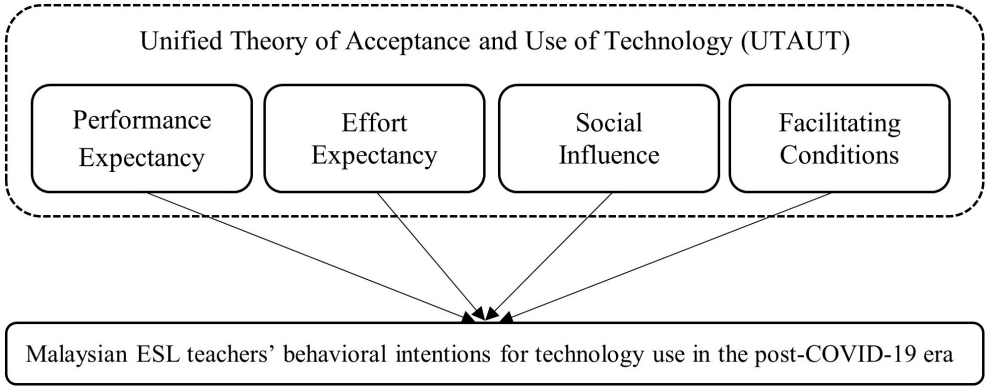

FIGURE 1
Conceptual framework of the study.

Ateş and Garzón, 2022). These items tended to examine the circumstances that affected the respondent's will to adopt technology, and referred to practices for facilitating ESL teaching and improving their performance by devising, adopting, and managing appropriate technological processes and resources to complete a certain task.

The questionnaire used in this study employed a 5-point Likert scale, with "strongly disagree" on one end, "strongly agree" on the other, and "neutral" in the middle. This approach was employed due to its practicality in measuring the participants' level of agreement or disagreement with a variety of statements about their attitude, which was relevant to this study (Taherdoost, 2019).

The instrument's construct validity was assessed to ensure that it was pertinent to the proposed study. Three experts specializing in related fields vetted the questionnaire. The reliability of this instrument was also examined to ensure its ability to produce similar results with repeated measurements. The items in the questionnaire each have a Cronbach's alpha coefficient between 0.74 and 0.96, which shows high reliability, as suggested by Sekaran and Bougie (2017).

2.4. Data collection procedure

The survey questionnaire was forwarded to Malaysian ESL teachers' social media platforms, such as Telegram, WhatsApp, and Facebook. Consent to use these platforms to disseminate the questionnaire was obtained from the administrators of the social media platforms. The teachers in the group were informed of the purpose of the survey questionnaire, and those who agreed to participate in the study were asked to follow the link provided, which then brought them to the Google Forms questionnaire. The data collection process ended after an adequate number of valid responses were received. The survey findings obtained *via* Google Forms were then transferred to Microsoft Excel and SPSS version 26.0 for data analysis.

2.5. Data analysis procedure

The data collected from the questionnaire were analyzed using SPSS version 26.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to determine ESL teachers' technology acceptance levels. Pearson's correlation analysis was then applied to identify the relationship between the factors in the UTAUT model and their BI in the post-COVID-19 era. Multiple regression analysis was conducted to test the research hypotheses and identify the factor that has the most significant impact on ESL teachers' BI toward use of technology in the post-COVID era.

3. Results

3.1. Research question 1: What is the technology acceptance level of Malaysian ESL teachers in the post-COVID-19 era?

Considering the first objective of this study, all valid responses were examined in the form of frequencies and percentages (Supplementary Table 2). All variables in this study were also analyzed descriptively, with the mean and standard deviation calculated for each domain. The interpretation of means followed guidelines for interpretation adapted from Best and Kahn (2006), in which a mean value in the range of 1.00–2.33 was taken to indicate a low level of acceptance, 2.34–3.67 a moderate level, and 3.68–5.00 a high level of acceptance. Table 1 summarizes the computed means and standard deviations of all the items according to the relevant construct.

According to Table 1, the means of all domains varied from 3.21 to 4.41, while the standard deviations of all variables ranged from 0.610 to 0.958, indicating a narrow spread of scores around the mean. The means of all variables (except FC) were at least 3.68, indicating that the overall technology acceptance level of the respondents is considered high.

TABLE 1 Malaysian ESL teachers' technology acceptance levels in the post-COVID-19 era.

Variable	Mean	Std. Deviation	Interpretation
Performance expectancy (PE)	4.41	0.610	High
Effort expectancy (EE)	4.15	0.674	High
Social influence (SI)	4.12	0.659	High
Facilitating conditions (FC)	3.21	0.958	Moderate
Behavioral intention (BI)	4.32	0.669	High

The findings demonstrate that Malaysian ESL teachers intended to employ technology in the post-COVID-19 era because they found it useful ($\bar{X} = 4.41$, $\sigma = 0.610$) and easy to use ($\bar{X} = 4.15$, $\sigma = 0.674$). Additionally, the influence of the people around them positively impacted their BI ($\bar{X} = 4.12$, $\sigma = 0.659$), resulting in a high mean for BI ($\bar{X} = 4.32$, $\sigma = 0.669$). On the other hand, a moderate level of acceptance indicated by the mean response regarding FC ($\bar{X} = 3.21$, $\sigma = 0.958$) implies that the respondents might adopt technology only to a moderate degree due to the lack of technology tools and resources available to conduct ESL lessons after the pandemic.

3.2. Research question 2: To what extent is there a relationship between the factors (PE, EE, SI, and FC) and Malaysian ESL teachers' behavioral intentions for technology use in the post-COVID-19 era?

To accomplish the second objective of this study, Pearson's correlation analysis was performed *via* SPSS version 26.0. A normality test was conducted prior to the analysis by examining the skewness and kurtosis of the data set. Both skewness and kurtosis values fell within the range of −1 to 1, indicating the normality and symmetry of the collected data (Orcan, 2020). Table 2 displays the Pearson correlation coefficient values of all the independent variables of this study with the dependent variable of behavioral intention.

The findings revealed that there are three moderately positive relationships between the factors and BI, namely those of PE ($r = 0.661$), EE ($r = 0.656$), and SI ($r = 0.585$). Conversely, there is a negligible relationship between FC ($r = 0.283$) and ESL teachers' BI. In other words, the relationship between the FC experienced by the respondents and their BI to use technology after the COVID-19 pandemic is minimal, resulting in a weak positive correlation between these variables.

The significance of the relationships between the factors in the UTAUT model and ESL teachers' BI to use technology was examined *via* multiple regression analysis. Table 3 shows the regression coefficients of each of the factors on ESL teachers' BI. The null hypotheses of this study were mainly rejected with reference to the presented findings of the current study.

3.2.1. Hypothesis 1: There is no significant relationship between PE and Malaysian ESL teachers' BI to use technology in the post-COVID-19 era

Hypothesis 1 is rejected as multiple regression analysis implies that this variable explains 43.7% of the variance in BI [$R^2 = 0.437$, $F(4,356) = 110.532$, $p < 0.01$]. PE significantly predicts ESL teachers' BI to use technology in the post-COVID-19 era [$\beta = 0.301$, $t(360) = 5.837$, $p < 0.01$]. PE also has a moderately positive correlation with their BI for technology use after the pandemic [$r(360) = 0.661$, $p < 0.01$]. This shows that ESL teachers' BI to use technology is boosted when they expect that it can improve their job performance.

3.2.2. Hypothesis 2: There is no significant relationship between EE and Malaysian ESL teachers' BI to use technology in the post-COVID-19 era

Hypothesis 2 is rejected as there is a significant regression equation in which $F(4,356) = 110.532$, $p < 0.01$, with an R^2 of 0.430, indicating that 43% of the variance in BI can be explained by EE. The multiple linear regression coefficient was calculated for the prediction of BI based on EE, $\beta = 0.325$, $t(360) = 6.614$, $p < 0.01$. The Pearson correlation test result also proves that EE has a moderately positive association with BI to use technology in the post-COVID-19 era [$r(360) = 0.656$, $p < 0.01$]. This indicates that ESL teachers are keen to apply technology for instructional purposes because they find it manageable.

3.2.3. Hypothesis 3: There is no significant relationship between SI and Malaysian ESL teachers' BI to use technology in the post-COVID-19 era

Hypothesis 3 is rejected as SI significantly predicts ESL teachers' BI to use technology after the COVID-19 pandemic, $\beta = 0.216$, $t(360) = 4.732$, $p < 0.01$. This variable explains 34.2% of the variance in BI, $R^2 = 0.342$, $F(4,356) = 110.532$, $p < 0.01$. SI also has a moderate and positive linear relationship with ESL teachers' BI to use technology after the COVID-19 pandemic, $r(360) = 0.585$, $p < 0.01$. This implies that ESL teachers are keen to adopt technology if the people around them persuade them to employ it in their ESL classroom.

3.2.4. Hypothesis 4: There is no significant relationship between FC and Malaysian ESL teachers' BI to use technology in the post-COVID-19 era

Hypothesis 4 is not rejected, as FC is not a significant predictor of ESL teachers' BI to use technology in the post-COVID-19 era

TABLE 2 Correlation between each of the factors and the respondents' behavioral intentions to use technology in the post-COVID-19 era.

		Performance expectancy (PE)	Effort expectancy (EE)	Social influence (SI)	Facilitating conditions (FC)
Behavioral intention (BI)	Pearson correlation	0.661**	0.656**	0.585**	0.283**
	Interpretation (Mukaka, 2012)	Moderately positive	Moderately positive	Moderately positive	Negligible
	Sig. (2-tailed)	0.000	0.000	0.000	0.000

**Correlation is significant at the 0.01 level (2-tailed).

TABLE 3 Regression of factors on the respondents' behavioral intentions (BI).

	Standardized coefficient (β)	*t*-value	Sig.	R^2
Performance expectancy (PE)	0.301	5.837	0.000	0.437
Effort expectancy (EE)	0.325	6.614	0.000	0.430
Social influence (SI)	0.216	4.732	0.000	0.342
Facilitating conditions (FC)	0.055	1.484	0.139	0.080

[$\beta = 0.055$, t (360) = 1.484, $p > 0.05$]. Moreover, the Pearson correlation test reveals a negligible relationship between FC and BI to use technology after the pandemic, r (360) = 0.283, p<0.01. FC explains only 8% of the variance in BI [$R^2 = 0.080$, F (4,356) = 110.532, $p < 0.01$], leading to failure to reject the null hypothesis in Hypothesis 4.

3.3. Research question 3: What is the most significant factor influencing Malaysian ESL teachers' behavioral intentions to use technology in the post-COVID-19 era?

In relation to the third objective of this study, the factor with the largest absolute value for the standardized coefficient (β), as shown in Table 3, represents the most significant factor in affecting teachers' intentions.

The results show that PE, EE, and SI are important in determining Malaysian ESL teachers' intentions. However, EE has the largest standardized coefficient ($\beta = 0.325$), implying that EE is the most significant factor. This variable is statistically significant at a level below the 0.01 level.

4. Discussion

4.1. Malaysian ESL teachers' technology acceptance level in the post-COVID-19 era

In relation to the first research question, Malaysian ESL teachers hold a high level of BI for the use of technology in the post-COVID-19 era, as BI had a mean and standard deviation of 4.32 and 0.669, respectively, with this mean value falling within the high-level range. Therefore, their high level of BI for technology use directly impacts their actual use of technology (Mohammad-Salehi et al., 2021; Kim and Lee, 2022; Sharma and Saini, 2022).

At the beginning of the pandemic, most Malaysian ESL teachers were not ready to implement ERT during the COVID-19 disruptions to regular classroom instruction. However, this lack of readiness did not affect their level of BI to integrate technology in the delivery of ESL lessons in the post-COVID-19 era. Based on the questionnaire findings, ~80% of the respondents intended to use technology for their future ESL teaching. Moreover, 84.2% of the respondents indicated that the COVID-19 pandemic had made them more inclined to employ technology more often when performing daily tasks in the future (Wen and Tan, 2020). This result is consistent with the findings of several researchers pertaining to relevant studies that have suggested that Malaysian ESL teachers tend to employ technology voluntarily in their daily working routines (Hu and AlSaqqaf, 2021; Omar and Hashim, 2021; Ting and Aziz, 2021; Siang and Mohamad, 2022).

In addition, this study has also identified the fact that most Malaysian ESL teachers express a willingness to adopt technology for use in various tasks that can improve their productivity. These tasks include the development of teaching aids ($n = 323$, 89.5%) and lesson delivery ($n = 322$, 89.2%). This finding parallels Li's study (2022), which found that teachers are willing to acquire technological knowledge and skills to integrate technology for instructional purposes. These findings suggest that Malaysian ESL teachers are accepting of technology and are willing to integrate it into their classrooms if they possess the requisite fundamental digital technology skills (Sari et al., 2021). Therefore, educational stakeholders should provide relevant training courses and programs to ESL teachers to develop their competency in ICT and apply the knowledge acquired in their respective ESL classrooms.

4.2. Relationships between the model factors and Malaysian ESL teachers' behavioral intentions for technology use in the post-COVID-19 era

The correlation results indicated that all factors in the UTAUT model, namely PE, EE, SI, and FC, are significantly correlated with respondents' BI to use technology in their ESL classrooms in future. Nevertheless, the result of the multiple regression analysis showed that their BI has a significant relationship only with PE, EE, and SI, whereas the factor of FC has no significant relationship with their BI to use technology in the ESL classroom during the post-COVID-19 era.

PE is identified as one of the factors that impact Malaysian ESL teachers' BI for using technology after the COVID-19 pandemic. In other words, teachers are concerned about whether technology can enhance the efficiency of their performance in their job (Yang et al., 2023). This finding is consistent with past studies, which also found an increase in teachers' BI to adopt technology if they found it useful and beneficial for them (Bajaj et al., 2021; Huang et al., 2021; Rashid et al., 2021; Ateş and Garzón, 2022; Mukminin et al., 2022; Khlaif et al., 2023). Relating the literature to the findings of the current study, Malaysian ESL teachers were exposed to technology in a way that they had never experienced before, enabling them to deliver ESL lessons at an optimum level. They utilized various websites and applications for lesson planning, for the preparation of teaching aids, and also for lesson delivery. Therefore, there is a strong possibility that Malaysian ESL teachers found technology to be effective in delivering lesson content during the COVID-19 pandemic (Al-Anezi and Alajmi, 2021; Mohammad-Salehi et al., 2021; Ting and Aziz, 2021), raising their BI to integrate technology for instructional delivery in their upcoming ESL lessons; this is contradictory to the findings of a few other studies (Sharma and Saini, 2022; Utami et al., 2022).

Moreover, EE is also vital in determining Malaysian ESL teachers' BI to adopt technology after experiencing ERT in conjunction with the COVID-19 pandemic. One of the most important factors for teachers to consider is the extent to which it is easy to use technology (Venkatesh et al., 2003). According to the findings of this study, they are more likely to have the intention of using technology if they find it user-friendly, as found in previous studies (Asghar et al., 2021; Dindar et al., 2021; Luik and Taimalu, 2021; Menabò et al., 2021; Rashid et al., 2021; Saidu and Mamun, 2022; Sharma and Saini, 2022). It is undeniable that most of them had to rely primarily on their digital devices throughout ERT during the pandemic. Accordingly, they were able to develop fundamental skills in handling mobile devices and digital applications. They were keen to continue using these for ESL instruction after the pandemic, as they found them easy to use and convenient (Gurer, 2021; Ting and Aziz, 2021).

Furthermore, the findings also demonstrate a significant relationship between the factor of SI and Malaysian ESL teachers' BI to employ technology in their post-COVID-19-era ESL classrooms. This indicates that they have greater intentions of using technological tools or applications if the people around them perceive this as beneficial or do the same. With reference to the questionnaire findings, the majority of Malaysian ESL teachers were influenced by their administrators, followed by peer teachers and colleagues. These findings are consistent with past studies, which have found that individuals close to teachers, such as colleagues, peers, and family members, were highly likely to engage with teachers and motivate them to use technology in implementing ERT during the COVID-19 pandemic (Asghar et al., 2021; Mohammad-Salehi et al., 2021; Rahman et al., 2021; Ting and Aziz, 2021; Jalil et al., 2022; Utami et al., 2022). Thus, in this study, it can be concluded that Malaysian ESL teachers receive positive influence and support from the people around them, resulting in their high level of BI to adopt technology in their work routines in the post-COVID-19 era.

In contrast, the results showed that the factor of FC does not have a significant relationship with Malaysian ESL teachers' intentions of adopting technology. Technology users' intentions to use technology will develop if they believe that they have access to the resources and tools needed to carry out their daily tasks (Wah and Hashim, 2021). Nevertheless, this study's findings indicated otherwise, showing that teachers' level of intention to use technology is not affected by the technological tools and resources at their disposal. This phenomenon could be explained using the findings obtained from the questionnaire. The descriptive analysis indicated that more than half of the respondents were doubtful or expressed disagreement that they had adequate technological equipment and resources, including Internet connection and technical assistance, resulting in a weak positive correlation and an insignificant relationship between FC and their intentions to use technology after the pandemic as testified by Aina and Opeyemi (2020). Although this finding failed to conform to the results presented in the majority of recent studies, there are also a number of studies that have reported similar results. For instance, Luik and Taimalu's study (2022) elucidated the fact that various technical challenges, such as a lack of technological devices and support, had impacted Nigerian teachers' ability to conduct online teaching, resulting in a lower level of technology acceptance. Similarly, some studies have reported that the presence of FCs has no effect on a technology user's BI to use technology systems due to an unsatisfactory level of FCs among users (Ramllah, 2020).

Taking all the findings into account, the conclusion of this study is that, of the four null hypotheses proposed, three were rejected; specifically, the factors of PE, EE, and SI were found to have significant relationships with Malaysian ESL teachers' BI to use technology in the post-COVID-19 era. In contrast, despite the discovery of a weak positive correlation between FC among Malaysian ESL teachers and their BI to use technology, the relationship between these variables is insignificant, resulting in failure to reject the null hypothesis. Due attention should be paid to this issue by educational stakeholders, as Malaysian ESL teachers could be encountering various constraints, such as a lack of access to sufficient technological facilities and devices to conduct ESL lessons, resulting in their reluctance to adopt technology in their respective ESL classrooms. In particular, a needs analysis should be conducted in future studies to identify Malaysian ESL teachers' requirements to provide quality ESL lessons.

4.3. The most significant factor affecting Malaysian ESL teachers' behavioral intentions for technology use in the post-COVID-19 era

Of the four factors discussed on the basis of the UTAUT model, PE, EE, and SI had a significant relationship with Malaysian ESL teachers' BI to use technology in their post-COVID-19-era ESL classrooms. However, EE emerged as the most significant factor affecting their BI, which suggests that the majority of Malaysian ESL teachers are more likely to have strong intention of integrating technology into their ESL classroom if they perceive doing so to be easy and effortless, as presented in previous studies (Asghar et al., 2021; Dindar et al., 2021; Luik and Taimalu, 2021; Menabò et al., 2021; Rashid et al., 2021; Saidu and Mamun, 2022; Sharma and Saini, 2022). If they find technology to be user-friendly, they will be accepting of it and attempt to implement it in their daily English lessons, resulting in positive development of their attitudes (Wah and Hashim, 2021). This can be explained by the amount of training they have previously received. Malaysian ESL teachers received adequate online training and attended multiple webinars to equip themselves with the relevant skills to use these online applications (Wen and Tan, 2020). Consequently, their digital competency level and perceptions of technology developed positively during the COVID-19 pandemic. Thus, they found technology to be simple and easy to use (Al-Anezi and Alajmi, 2021).

5. Conclusion

This study has achieved its objectives, as both ESL teachers' technology acceptance levels and factors affecting their behavioral intentions for technology use were identified. ESL teachers generally have a high level of technology acceptance, having embraced technology as one of the inevitable components of their work routine after being immersed in an ERT environment that relied on heavy use of technology throughout the pandemic. Consequently, they demonstrate a high degree of willingness to adopt technology in their post-COVID-19-era ESL classrooms. Moreover, PE, EE, and SI play vital roles in influencing teachers' BI to use technology in their ESL teaching in the post-COVID-19 era. This finding indicates that they are more likely to adopt technology in their ESL classrooms if they find it useful and easy to use, or if they are encouraged to do so by the individuals around them. Specifically, EE is the most significant factor, indicating that teachers are keen to use technology in the future if they find it effortless and uncomplicated to apply in their ESL classrooms.

This study constitutes an important contribution to the educational psychology literature, as it sheds light on the extent to which ESL teachers' behavioral intentions for technology use will be affected by the factors described in the UTAUT model; in particular, the findings demonstrate the changes in technology acceptance levels that have occurred due to the implementation of emergency remote teaching in dealing with the crisis of the COVID-19 pandemic. This study provides added value and insights for curriculum stakeholders and planners in terms of ways to encourage more ESL teachers to accept and employ technology to optimize the quality of their teaching. As this study found an insignificant relationship between facilitating conditions and ESL teachers' behavioral intention, educational stakeholders should investigate this issue further and take necessary actions to develop infrastructure, policy, instructional strategies, and design to enhance the acceptance and actual use of technology among ESL teachers.

For researchers who intend to further explore this topic, there are some suggestions that should be considered. Longitudinal research can be conducted to compensate for the drawbacks of the cross-sectional design adopted in this study. Moreover, future studies should attempt to widen the range of possible explanatory variables and include supplementary moderating or intervening variables from the UTAUT model and other technology acceptance models, such as the Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB). Future studies could also compare technology acceptance between different demographic backgrounds, a line of investigation that is lacking in this study. It is feasible to explore how cultural and contextual factors contribute to ESL teachers' behavioral intentions of integrating technology in their ESL classrooms.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

TWC and MMY conceived the study, participated in its design and coordination, performed the final analyses, and co-drafted the manuscript. TWC collected field data, entered study data, and assisted in the data analysis and interpretation of study results. Both authors read, revised, and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships

that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1127272/full#supplementary-material

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Factors influencing teachers' satisfaction and performance with online teaching in universities during the COVID-19

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The COVID-19 pandemic has significantly changed the teaching model, promoting educational institutions to initiate more explorations in online teaching. This study examines the factors influencing teachers' online teaching performance and satisfaction in universities during the COVID-19. We applied a model of technology acceptance (TAM), expectation confirmation (ECM), and computer self-efficacy (CSE) to develop a questionnaire. The survey was used to collect data from 347 teachers from 6 universities in eastern China to identify factors affecting teachers' performance and satisfaction during the COVID-19. The results indicated that teachers' performance of online teaching is significantly affected by satisfaction, perceived usefulness, and perceived ease of use of online teaching. Meanwhile, confirmation of online teaching expectations and computer self-efficacy significantly impacted teachers' satisfaction with online teaching. This work is an original empirical study guided by multiple theories. It contributes to the online education literature and provides advice regarding how teachers' online teaching satisfaction and performance can be developed in a situation like the one that occurred with COVID-19. This work also broadens the application of TAM and provides an alternative theoretical framework for future research on teachers' online teaching performance.

KEYWORDS

online teaching, performance, satisfaction, expectation confirmation theory, computer self-efficacy

1. Introduction

Online teaching has become an essential tool in education because of the rapid development of the Internet and information technology (Sepulveda-Escobar and Morrison, 2020). Numerous studies (Yang et al., 2018; Heinrich et al., 2019) have confirmed that online teaching has made a significant contribution to educational opportunities and promoted educational equity (Yang et al., 2018). Empirical research (Mandasari, 2020; Supriyatno et al., 2020; Gopal et al., 2021) has confirmed that online teaching and hybrid teaching (online-offline teaching mode) have positive effects on improving students' performance, motivation, and learning ability compared with traditional teaching methods.

The large-scale outbreak of the COVID-19 pandemic poses great challenges for face-to-face teaching, and many colleges and universities have closed their campuses and suspended physical teaching and learning activities (Ye et al., 2022). Countries with sophisticated network infrastructure setups have switched to online teaching and have rapidly set up online learning administration systems to bring children back to the classroom. This has been an effective

measure to address the shortcomings of face-to-face education during the pandemic (Kruse et al., 2022). For example, the Chinese government mandated distance learning programs for students during school closures because schools experienced huge disruptions in education in the spring of 2020. The policy is named "Classes Suspended, Learning Continues." Compared with primary and secondary schools, colleges and universities have enforced this policy more strictly. Universities have a good technical platform and resources to support online teaching because they have conducted online courses for decades. According to statistics from the Chinese Ministry of Education, 1.03 million teachers from 1,454 universities delivered online courses to 17.75 million college students to alleviate problems associated with COVID-19 restrictions and face-to-face instruction (Ministry of Education of the People's Republic of China, 2019).

However, unlike in the past when teachers and students were fully prepared for the online course, the COVID-19 pandemic abruptly forced teachers and students to switch from traditional classroom learning to online learning. Many teachers and students did not have plans and experience in this mode of teaching (Orlov et al., 2021). Thus, a sudden switch from face-to-face teaching to distance learning brings many challenges and constraints (Carrillo and Flores, 2020). With the "rush" and "involuntary" learning, the online learning experience for students and teachers is different from traditional face-to-face learning. In this context, researchers (Gopal et al., 2021; Khan et al., 2021; Ye et al., 2022) have started exploring the teachers' and students' satisfaction with online teaching. The goal is to offer suggestions about the quality of online education and the feelings of college teachers and students regarding online learning. Using theories such as online learning ability, connectivism, and achievement goal theory (AGT), researchers have discussed critical success factors that influence the effectiveness of online learning during the pandemic. Gopal et al. (2021) used AGT to identify four independent factors affecting students' online learning performance, which included teacher quality, curriculum design, timely feedback, and student expectations. Khan et al. (2021) investigated the effects of Internet quality, prior knowledge of information communication technology (ICT), household income, and mother's education level using quantitative survey methods.

Studies reported that teacher satisfaction, as one of the five pillars of the Sloan Alliance's high-quality online education, is a key factor that affects the quality of online teaching (Bolliger, 2004; Bolliger et al., 2014). Other studies (Panisoara et al., 2020; Sims and Baker, 2021; Almulla, 2022) have also analyzed the factors influencing teachers' online teaching satisfaction during the COVID-19 pandemic based on the technology acceptance model (TAM), expectation confirmation theory, and self-efficacy theory. For example, Sims and Baker (2021) surveyed 183 faculties at master's-level in different Midwest universities to evaluate the rapid transition from traditional courses to online media during the spring 2020 semester. They found that teacher satisfaction with online teaching was low due to a drop in student engagement. Using the TAM, Almulla (2022) also explored the critical factors that influenced online teaching skills, competencies, and the use of digital tools in higher education. The outcome of their survey shows that perceived ease of use and perceived usefulness of using digital devices have a positive impact on lecturers' behavioral intention to use digital tools during the COVID-19 pandemic.

However, the aforementioned reviewed studies have examined the various factors affecting teachers' online teaching satisfaction, none of these studies has explained the direct relationship between teachers' online teaching satisfaction and performance. Satisfaction is an inner psychological experience, which induces changes in performance (Luqman et al., 2017). Blundell et al. (2020) revealed that faculty satisfaction with online teaching during the COVID-19 pandemic was influenced by three main factors: instructor-student interaction, technology's role, and institutional support. However, they did not explore the relationship between teacher satisfaction and teacher performance.

School closures brought about by the COVID-19 pandemic leave teachers unprepared and unready for online teaching. In China, college teachers have repeatedly used hybrid teaching since 2020, which has brought a lot of teaching pressure on teachers. Therefore, evaluating the factors that influence teachers' online teaching satisfaction and performance is critical because it has important implications for teachers, education administrators, and technology providers.

This study develops a theoretical model, which integrates the TAM, expectation confirmation theory (ECT), and computer self-efficacy (CSE) to explore the factors influencing the satisfaction and performance of teachers for online teaching behavior. This framework addresses the relative relationship between people's pre-expectation of a product or service and the actual feeling, based on three levels: the sense of use, the effect of use, and difficulties encountered in the process of use. By proposing and validating the framework, we aim to answer the following research questions:

(1) Does teachers' satisfaction with online teaching affect their online teaching performance?
(2) Which elements are critical drivers for teachers' performance and satisfaction in online teaching?
(3) To what extent do these drivers explain teachers' online teaching satisfaction?

We review past literature and conduct an empirical analysis to answer these questions.

The remainder of the paper is organized as follows. Section "Literature review" reviews the existing studies that use TAM, ECT, and CSE in explaining teachers' satisfaction and performance with online teaching. Section "Research model and hypotheses" proposes the research model and hypotheses, and Section "Research methodology" describes research methods, including structural measurements and data collection. Section "Results" presents data analysis and hypothesis testing results, and Section "Discussion" discusses the results. Finally, Section "Conclusion" concludes the paper.

2. Literature review

2.1. Performance

Job performance can be defined as the total expected value to the organization of the discrete behavioral episodes that an individual conducts over a standard period of time (Wen et al., 2019). Teaching performance refers to a teacher's work shown in carrying out the tasks, roles and responsibilities in order to achieve school goals (Kusumaningrum et al., 2019). Teaching performance is the most

significant contribution to the educational process. It determines whether teachers can teach and deliver reliable teaching results in new teaching environments and when facing new demands and challenges. With an increasing demand for online teaching, teachers' performance has become a critical factor in evaluating online education quality. Zhu et al. (2022) pointed out that online teaching performance was affected by teachers' concepts, abilities, and experience, especially when applying ICT, which were essential factors affecting the effectiveness of online teaching. Xiang et al. (2021) confirmed that teachers' performance in online teaching, such as having teaching proficiency, having teaching information, and answering questions, has significantly affected the quality of online teaching.

2.2. Satisfaction

Satisfaction refers to the post-consumption experience and post-use decidsion of a product, system, and service (Ali et al., 2021). Teachers' satisfaction is an essential factor in evaluating the quality of online courses and has been extensively analyzed in research focusing on modern educational technology-driven instruction (Blundell et al., 2020). Wingo et al. (2017) summarized 67 empirical studies about online teaching using TAM 2 framework. The results show that factors affecting teachers' online teaching satisfaction are barriers to student success in online classes, technical support needs, uncertainty about the image of online instructors, desire for a reasonable workload, and class enrollments in online courses.

2.3. Technology acceptance model

TAM is first proposed by Davis (1985), and it has become a classic model to predict and explain people's attitudes and intentions to use new information technologies or information systems. The field of education is no exception (Scherer et al., 2019; Han and Sa, 2021). TAM assumes that individuals' behavioral preferences to use IT depend on their satisfaction and perceived ease-of-use (refers to the ease of using a specific type of IT) and perceived usefulness (refers to the extent to which the technology improves work performance). These are the two most essential factors influencing individuals' attitudes toward usage (Venkatesh and Davis, 2000). With the increasing application of new ICT in education (Akram et al., 2021; Bajaj et al., 2021), the effectiveness of TAM has been proved by empirical research to explain teachers' attitudes toward online teaching (Siyam, 2019; Mailizar et al., 2021). For example, Bajaj et al. (2021) used TAM to explain teachers' intention to continue using online teaching tools during COVID-19. They found that ease of use of technology positively influences teachers' attitudes toward online teaching. Compared with female teachers, male teachers are more inclined to use online teaching platforms during COVID-19. Akram et al. (2021) used empirical analysis to demonstrate that Pakistani teachers faced challenges in online teaching during the COVID-19 pandemic. They found a favorable attitude of faculty members toward using virtual education platforms. However, faculty members encountered several challenges that caused restrictions in accomplishing competent teaching and learning. For example, they lacked experience in conducting online classes and were not given adequate technical assistance or ICT infrastructures. The above-reviewed studies in this subsection have shown that TAM can provide clear variables for identifying factors influencing teachers' satisfaction with online teaching and for offering considerable operability and effectiveness in examining the attitude toward online teaching. Given the above context, this study uses TAM to assess Chinese university teachers' satisfaction with online teaching during the COVID-19 pandemic.

TAM estimates technology intention through subjective perceptions of the "usefulness" and "ease of use" of the technology. However, perceived usefulness and ease of use are broad constructs and cannot capture the specific instrumentality of users' technology adoption behavior. Therefore, studies (Guo et al., 2017; Du et al., 2022) often extend and adopt the TAM in analyzing users' technology intention for examining the specific factors influencing user experience.

2.4. Expectation–confirmation model

Expectation–Confirmation Model (ECM), sourced from the expectation–confirmation theory (ECT; Oliver, 1980), is the most adopted model used to analyze the satisfaction development process. The model reveals the correlation between satisfaction and consumers' post-adoption expectations of the service/product based on their experience (Nam et al., 2020). However, Bhattacherjee (2001) argues that the theory has some weaknesses because it ignores potential changes that customers expect after a consumption experience and the impact of those changes on subsequent cognitive processes. In this respect, Bhattacherjee developed an ECM of information system (IS) continuance to explore users' satisfaction and continuance behaviors in the context of ISs. This model modifies the ECT by extending the post-acceptance expectation of the user and expressing it in terms of perceived usefulness.

Recently, ECM of IS continuance has been extended into e-learning to explore learner satisfaction for online courses. Daneji et al. (2019) explained examines the effects of students' perceived usefulness, confirmation and satisfaction on MOOC continuance intention by ECM and revealed that students' confirmation has significant effects on their perceived usefulness and satisfaction. Zhu et al. (2020) examined the changes in university students' attitudes toward online learning by ECM and TTF, and found that university students' online learning attitudes were generally positive. Their continuous intention to learn online was significantly predicted by their self-regulated learning capability, online interactions, attitudes, and online learning intention. They verified that expectation confirmation was a significant predictor for gaining perceived usefulness.

2.5. Computer self-efficacy

CSE represents an individual's efficacy in performing specific computer-related tasks within the domain of general computing (Teo et al., 2018). As an application of self-efficacy in electronic information, CSE is derived from the social-cognitive theory of individual behavior, which explains human behavior in terms of the interplay between behavioral, cognitive, and environmental determinants (Bandura, 1997). Compeau and Higgins (1995) applied the concept of

self-efficacy to information technology, which referred to an individual's ability to accomplish a particular task using a computer system (Shen and Eder, 2009). The CSE model has focused on specific applications from a broad range of general computing tasks. In the e-learning field, several studies on online learning satisfaction highlight the importance of the CSE model for a successful online learning experience. Wang et al. (2019) found that CSE significantly affect the intention of students to continue using Cloud e-learning application. Likewise, Katsarou (2021) also believed that high CSE levels were important factors that promoted students' academic success in the current digital era because CSE levels reduced technology anxiety and increased positive attitudes toward e-learning.

The CSE model is appropriate for this study because of two reasons: First, CSE provides new insights into computer system use behavior, which proves that individuals with a strong sense of capability are more willing to accept and use the system (Jan, 2015; Abdullah and Mustafa, 2019). Second, the model provides a concise and structural way of examining the impact of a user's inherent ability awareness on the user's experience in technology. In the urgent shift to online teaching caused by COVID-19, teachers with high technology awareness are more active in overcoming unexpected online teaching challenges, generating a better online teaching technology experience, and achieving better user satisfaction (Zhao and Zhao, 2021). Therefore, we apply this model to online teaching to identify such teachers' behaviors and the consequences.

3. Research model and hypotheses

The study established an integrated model of TAM, ECM, and CSE to explore the predictors of teachers' satisfaction in the online teaching context. In the research model, expect confirmation factors (i.e., expectations of teaching goal achievement, expectations for a quality classroom interaction, and expectations for student satisfaction) were applied to represent perceived usefulness. We also adopted teachers' ability in using online teaching platforms and in solving technical difficulties associated with the CSE factors. Figure 1 depicts the research model and the proposed hypothesized relationships.

3.1. Relationship between online teaching satisfaction and teaching performance

The relationship between satisfaction and performance has been examined in various organizational settings. Petty et al. (1984) conducted a meta-analysis on the relationship between job satisfaction and job performance from 1963 to 1983. They confirmed a positive relationship between job satisfaction and performance. In the field of education, Torres (2019) describes teachers' satisfaction as the level of fulfillment gained from work. The critical impact of teachers' job satisfaction on their teaching performance has been demonstrated by many studies (Li et al., 2018; Wolomasi et al., 2019; Sudirman et al., 2021). For example, Li et al. (2018) found that job satisfaction positively supports teachers' job performance. Therefore, hypothesis 1 is formulated.

> *H1*: Teachers' satisfaction is positively associated with teachers' performance in online teaching.

3.2. Relationship between perceived ease of use, perceived usefulness, online teaching satisfaction, and performance

Perceived ease of use of online teaching is the degree of adaptability of teachers to the online teaching model and the comfort level of teachers to use online teaching tools. Several studies have confirmed that adopting digital tools for teaching and learning is a critical indicator of attitude toward technology adoption (Briz-Ponce and García-Peñalvo, 2015; Mehta et al., 2019). According to Hu and Xie (2020), Chinese college instructors adopted more than 10 online teaching methods during the pandemic, including live broadcast + online interaction, recording + online interaction, student self-learning + online interaction, SPOC (small private online course), and PPT (PowerPoint presentation) + online discussion. Online interaction is a crucial part of all teaching methods. Different teaching methods are accompanied by various online teaching tools, which significantly challenges teachers' online teaching ability. Given the existing research on the application of TAM in IT-based teaching, this study considers the perceived ease of use of online instruction, which comprises three components: perceived comfort of operating online teaching tools, perceived ease of online class design, and perceived ease of interaction in online classes.

Perceived usefulness is defined as digital tools used to solve existing pedagogical problems or improve pedagogical effectiveness (Pańkowska et al., 2020). Lin et al. (2011) argue that teachers' perceived usefulness to online teaching is based on how this teaching mode helps achieve their learning goals. Sims and Baker (2021) explore faculty perceptions of online teaching during COVID-19 based on three aspects: the quality of online teaching, the transition from face-to-face classes to online classes, and students' performance and course completion. All three are adopted in this study as dimensions of the perceived usefulness of online teaching.

Satisfaction is defined as a sense, derived from the post-assessment of a consumer product or service experience (Liu et al., 2018). When the perceived performance meets or exceeds individual expectations, the feeling of satisfaction occurs (Palacio et al., 2002). Perceived usefulness and ease of use are stable indicators of users' emotional disposition toward technology than other factors, such as technology safety. Thus, some studies have indicated that teacher readiness and use of the TAM positively and significantly impact teacher performance during COVID-19 (Sulistiyani and Nugroho, 2022). Accordingly, the higher the quality of online teaching to solve the problem of educational interruption caused by the epidemic, the higher the satisfaction with the technology adopted within teachers. The ease of online teaching and tools also affects teachers' emotions and effectiveness, which in turn affects teachers' satisfaction and performance. Therefore, the following hypotheses are formulated.

> *H2*: Perceived usefulness is positively associated with teachers' performance in online teaching.

> *H3*: Perceived ease of use is positively associated with teachers' performance in online teaching.

> *H4*: Perceived usefulness is positively associated with teachers' satisfaction with online teaching.

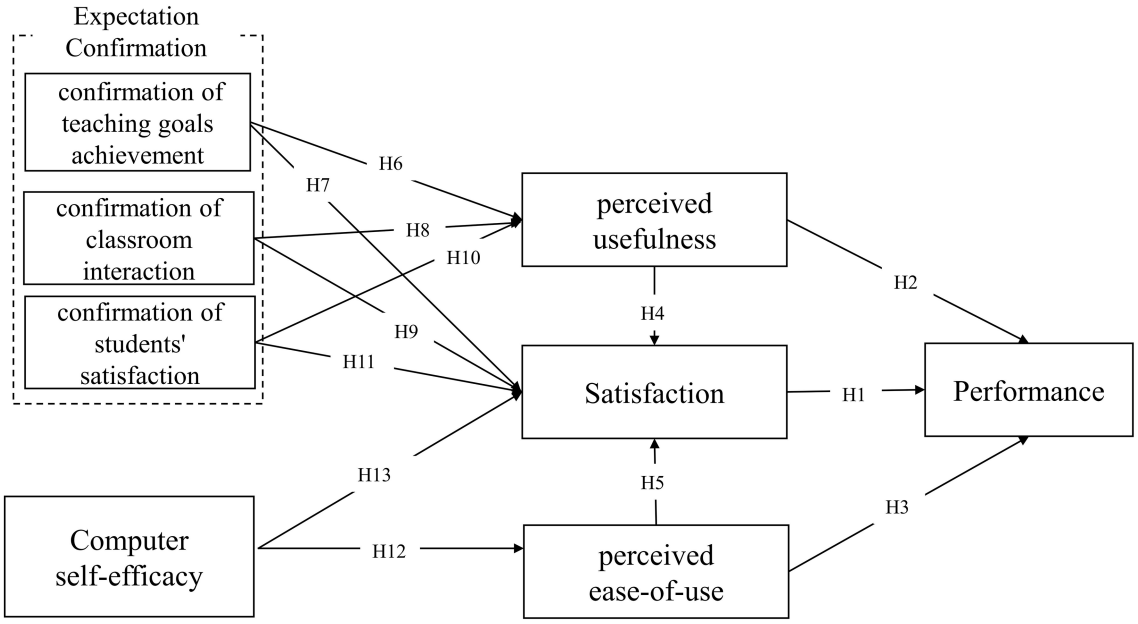

FIGURE 1
Research model.

H5: Perceived ease of use is positively associated with teachers' satisfaction with online teaching.

3.3. Relationship between expectation conformation, perceived usefulness, and online teaching satisfaction

The confirmation of expectations suggests that users obtain expected benefits through usage experiences, which leads to a positive effect on users' satisfaction (Bhattacherjee, 2001). Expectation confirmation is used to assess the functionality and usefulness of online teaching pedagogical applications (Tan and Shao, 2015; Zhou, 2017). Empirical studies reveal that this desired conformation-to-satisfaction relationship influences perceived usefulness. Lee (2010) found that users' confirmation of expectations was positively correlated to their perceived use based on the predicted users' continuance intention toward e-learning using an expectation–confirmation extension model. Alraimi et al. (2015) found a significant relationship between users' confirmation of expectations and the perceived usefulness of MOOCs' continuance.

ECM variables implicitly assume that behavior is voluntary. Thus, it is crucial to explore factors that influence these variables and how they are manipulated to improve teachers' experience in online teaching. Webster and Hackley (1997) summarized the factors that affected distance learning into four aspects: technical characteristics, teacher characteristics, curriculum characteristics, and learner characteristics. Using confirmation of expectations, Zhou et al. (2017) divided the use of e-learning into three aspects: knowledge outcome, performance proficiency, and social influence. These represent the learners' perception of subject matter understanding, the degree to which an individual possesses the required knowledge, skills, abilities, and influence from others' evaluations (Yu et al., 2010; Wei et al., 2011; Wan et al., 2012). Zhu et al. (2022) and Zheng et al. (2022) have shown that in the face of unexpected online teaching, teachers have developed the following adaptive anxiety: teaching effect, teacher-student interaction, and student learning guidance. Therefore, we adopted the perceived usefulness of online teaching and identified teachers' expectations of teaching goal achievement, online classroom interaction, and student satisfaction.

Teaching achievement is how well teachers complete their teaching objectives through online teaching. Achievement goal theory suggests that motivation and achievement-related behavior can easily be understood through purpose and people's engagement in activities (Bardach et al., 2020; Urdan and Kaplan, 2020). As a compensatory teaching method during the epidemic, the most crucial purpose of online teaching is to help teachers complete their teaching plans and achieve their teaching goals. Teachers will perceive the usefulness of online teaching and become satisfied when online learning achieves impressive teaching goals. Hence, we hypothesized:

H6: Confirmation of teaching goal achievement while using online teaching has a positive effect on perceived usefulness.

H7: Confirmation of teaching goal achievement while using online teaching has a positive effect on teachers' satisfaction.

Classroom interaction refers to the exchange, cooperation, and communication between teachers and students. Teaching is a behavioral interaction process between teachers and students. In online teaching environments, a reduction in social presence and appropriate classroom interaction activities has become a thorny problem for teachers because of time and space constraints. Existing research has found that positive classroom interactions can enhance the student's learning experience and improve teaching quality (Malik et al., 2010; Martínez-Argüelles and Batalla-Busquets, 2016). Teachers

will perceive the usefulness of online teaching and become satisfied when high-quality interactions are established. Hence, we hypothesized::

> *H8*: Confirmation of online classroom interaction has a positive effect on perceived usefulness.
>
> *H9*: Confirmation of online classroom interaction has a positive effect on teachers' satisfaction.

According to Awidi and Paynter (2019), student satisfaction refers to a positive affective state that results from the evaluation of the teaching module and method. In classroom teaching, teachers can captures the affective state of students through dialog with students and observe students' movements and facial expressions, and to understand students' learning investment and control teaching progress (Yang and Zhang, 2020). If students show a positive affective state with classroom teaching, teachers will believe that the education has achieved good results. Therefore, we hypothesized:

> *H10*: Confirmation of student satisfaction while using online teaching has a positive effect on perceived usefulness.
>
> *H11*: Confirmation of student satisfaction while using online teaching has a positive effect on teachers' satisfaction.

3.4. Relationship between computer self-efficacy, perceived ease of use, and online teaching satisfaction

Studies have shown that CSE influences users' perceptions of information technology/product use (Jan, 2015). Users with higher CSE generally experience fewer barriers to technology, and this improves their positive attitude toward the use of the technology (Cherry and Flora, 2017; Teo et al., 2018).

Numerous studies have confirmed the positive correlation between CSE and perceived ease of use of technology. Bai et al. (2021) found that CSE significantly enhanced the ease of use of technology, indicating that when teachers believed in their skills to use ICT tools, they were more likely to use specific ICT tools to enhance their teaching performances. Self-efficacy includes an individual's belief in one's skills to complete specific tasks, to enhance an individual's resistance to obstacles, and to enhance persistence in the face of setbacks and determination to complete complex tasks (Bandura, 1997). In the online education environment, the participants' belief in their ability to use online teaching technology and their confidence in facing difficulties associated with online teaching. Some studies believe in primary manifestations of the participants' computer self-efficacy (Hampton et al., 2020; Huang et al., 2022). Accordingly, the following hypotheses are proposed:

> *H12*: Teachers' computer self-efficacy for online teaching positively affects perceived ease of use.
>
> *H13*: Teachers' computer self-efficacy for online teaching positively affects teachers' satisfaction.

3.5. Control variables

Since prior researchers (Guo et al., 2017; Li et al., 2018) considered that participants' individual demographic characteristics might potentially influence the relationships of performance, we added gender and teaching years as control variables in the analyses.

4. Research methodology

4.1. Questionnaire design

We developed a questionnaire to analyze the factors influencing teachers' performance and satisfaction with online teaching. Eight constructs have been measured. Some items on the questionnaire were self-developed based on the research results of previous studies (Compeau and Higgins, 1995; Bhattacherjee, 2001; Pecheone and Chung, 2006; Zhou, 2017; Teo et al., 2018; Hampton et al., 2020; Qin and Zhou, 2020; Wei and Chou, 2020; Bajaj et al., 2021; Sims and Baker, 2021; Sharma and Saini, 2022); whereas others were adapted from measures that previous studies had validated. The Performance Assessment for California Teachers (PACT) was used to evaluate teacher performance in five dimensions: (1) how to plan learning goals and student needs, (2) how to engage in purposeful instruction and reflect on the results, (3) how to evaluate student learning, (4) how to prepare for next steps for individual students and (5) how to prepare for the class. This assessment has been widely accepted to assess in-depth teaching performance (Pecheone and Chung, 2006). Therefore, we adapted the item on teacher performance from the PACT. The scales measuring satisfaction were self-developed based on the research results of Bhattacherjee (2001). The perceived usefulness and ease of use items were adapted from Qin and Zhou (2020) and Sharma and Saini (2022), respectively. For expectation confirmation, the items measuring confirmation for online classroom interaction and student satisfaction were adapted from Hampton et al. (2020) and Bajaj et al. (2021) models. Moreover, the items for confirmation of instructional goal achievement were self-developed based on results by Zhou (2017) and Sims and Baker (2021). The items for computer self-efficacy were adapted from Compeau and Higgins (1995), Wei and Chou (2020), and Teo et al. (2018).

The questionnaire items were written in Chinese using a seven-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). As some of the items were in English, we translated them into Chinese and made the necessary modifications for easy understanding. These measure items are listed in Table 1.

4.2. Sample and data collection

Samples have been collected from six universities from eastern China. These universities conducted online teaching several times in 2020–2022 because of the COVID-19 epidemic. Teachers and students have turned to online education at least three times in the past six semesters. For example, these six universities have just launched online teaching in the summer semester of 2022. They also used an online teaching platform for the final exam. Teachers at these schools have rich online teaching experience. Therefore, they are ideal places for our research. We contacted some teachers at six universities in eastern China through former classmates, colleagues, and personal contacts.

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TABLE 1 Observed variables influencing teachers' online teaching behavior.

Dimension	Observed variables
Online teaching performance (a)	a1 Be able to make online teaching plans around learning goals and student needs
	a2 Be able to teach online with a purpose
	a3 Be able to reflect on the effectiveness of online teaching
	a4 Be able to provide positive feedback on student learning
	a5 Be able to help students develop personalized learning plans
Online teaching satisfaction (b)	b1 Satisfaction with the teaching effect of online teaching
	b2 Satisfaction with the teaching experience of online teaching
	b3 Feel the values of online teaching
Perceived usefulness (c)	c1 Effectively organize learning resources
	c2 Effectively implement classroom teaching activities
	c3 Effectively carry out classroom teaching evaluation
Perceived ease-of-use (d)	d1 Ease of operating online teaching platforms and tools
	d2 Ease of providing flexible teaching features
	d3 Ease of organizing online classroom teaching
Confirmation of teaching goal achievement (e)	e1 Complete expected teaching progress
	e2 Complete expected teaching goals
	e3 Improve teaching effectiveness.
Confirmation of online classroom interaction (f)	f1 Establish effective communication with students
	f2 Establish effective communication among students
	f3 Catch individual students' needs.
Confirmation of student satisfaction (g)	g1 Students show satisfaction with the classroom effect
	g2 Students show satisfaction with learning achievement
	g3 Students show satisfaction with classroom interactions
Computer self-efficacy of online teaching (h)	h1 Confidently perform essential functions of an online teaching platform
	h2 Confidence to carry out online teaching or online and offline hybrid teaching.
	h3 Could complete online teaching if used similar technologies.
	h4 When have technical difficulties in online teaching, specialized instruction is available

Relying on these teachers we are familiar with, we randomly recruited 50–60 teachers from each school to participate in the questionnaire survey. Finally, a total of 355 teachers agreed to participate in the survey.

We consulted seven experts in higher education and teachers' professional development for the questionnaire content validity before the survey. Then, we revised the questionnaire structure and language using experts' feedback. We launched a pre-survey, distributed 150 questionnaires across two universities in Jiangsu Province, China, and collected 142 results. We tested the data group's internal consistency reliability using Cronbach's alpha coefficient. From the results, Cronbach's alpha coefficient of the questionnaire was 0.836; Cronbach's alpha coefficients for each component were 0.943, 0.852, 0.798, 0.819, and 0.813. The questionnaire had good reliability because all these Cronbach's alpha coefficients were above 0.7. Thereafter, we launched an 8-week survey. We emailed these teachers the link to the survey and a description of the purpose of the study. However, among the returned questionnaires, eight questionnaires showed obvious regular answers. Therefore， we collected 347 valid questionnaires for data analysis. Table 2 shows the demographic characteristics of the respondents.

TABLE 2 The demographic characteristics of the respondents (*N*=347).

Measure	Items	Frequency	Percentage (%)
Gender	Male	186	53.6
	Female	161	46.4
Teaching years*	1–5	187	53.8
	5–10	123	35.4
	more than 10	37	10.8
Teaching Area**	Philosophy	35	10.2
	Economics	21	5.9
	Management	32	9.2
	Law	15	4.5
	Education	61	17.5
	Literature	36	10.4
	History	26	7.6
	Science	34	9.8
	Engineering	29	8.4
	Agriculture	0	0
	Medicine	12	3.3
	Military	0	0
	Art	46	13.1

*In China, universities usually sign employee contracts with teachers every five years.
**According to the Subject Catalog of Degree Conferment and Talent Cultivation, there are 13 disciplines of undergraduate education in China.

4.3. Data processing and reliability and validity testing

The study model was analyzed using partial-least-squares (PLS) regression. PLS is a widely used model for the regression of multiple dependent and independent variables and for handling latent variables with multiple indicators in a single model. Meanwhile, It is also suitable for dealing with non-normal distribution data and small sample sizes. Many studies have proved PLS is the preferred approach for theory development, exploratory research, and existing theory extension (Gefen et al., 2000; Hair et al., 2011). This work's primary research goals are to develop satisfaction and performance theory and explore the factors that influence teachers' online teaching performance and satisfaction. Therefore, PLS is appropriate for our study. According to Chang et al. (2014), data analysis was performed in two steps: (1) the reliability and validity of the measurement model were analyzed; (2) the data of the structural model were interpreted. Data processing and analysis were performed using the software SmartPLS 3.3 developed by the University of Hamburg (Ringle et al., 2015).

The reliability and validity of all variables were tested to verify the measurement model. From the results in Table 3, the construct

TABLE 3 CR, AVE, and correlation coefficients of latent variables.

Dimension	CR	AVE	A correlation coefficient of latent variables							
			1	2	3	4	5	6	7	8
1. Online teaching performance	0.77	0.73	0.85							
2. Online teaching satisfaction	0.73	0.79	0.44	0.89						
3. Perceived usefulness	0.82	0.65	0.39	0.55	0.81					
4. Perceived ease-of-use	0.81	0.82	0.12	0.58	0.61	0.91				
5. Confirmation of teaching goal achievement	0.92	0.76	0.52	0.43	0.38	0.57	0.87			
6. Confirmation of online classroom interaction	0.74	0.69	0.41	0.22	0.33	0.56	0.62	0.83		
7. Confirmation of student satisfaction	0.85	0.61	0.27	0.31	0.26	0.42	0.29	0.47	0.78	
8. Computer self-efficacy of online teaching	0.89	0.64	0.69	0.39	0.48	0.30	0.23	0.51	0.66	0.80

The numbers highlighted in gray are the square roots of AVE and should be greater than other correlation coefficients.

reliability of all variables in any construct is greater than 0.7, proving that the data are sufficiently reliable (Gefen et al., 2000).

According to Fornell and Larcker (1981), the convergent validity of the measurement model is ascertained when all observed variable loadings are greater than 0.7, and the average variance extracted (AVE) of all variables is greater than 0.5. Table 4 shows that the loadings of all observed variables are greater than 0.7, and the AVE is between 0.61 and 0.82, proving that the convergent validity of the observation model meets the statistical requirements.

Additionally, discriminant validity must satisfy the following two criteria: the correlation coefficient between variables should be less than 0.85, and the square root of the AVE of each variable should be greater than the correlation coefficients of other variables in the model (Fornell and Larcker, 1981). Table 3 shows that the correlations between variables and the square roots of AVE are found on the diagonal of the table, all satisfying the above two criteria and proving that the measurement model has acceptable discriminant validity.

The variance inflation factor (VIF) was calculated for all variables to prevent multicollinearity problems. According to Hair et al. (2006), a model suffers from multicollinearity problems when the VIF exceeds 10. We ran VIF tests, and the calculation result showed that none of the VIF values exceeded 5.1, confirming the absence of significant multicollinearity problems in the model.

Furthermore, common method bias (CMB) should be tested as all samples were collected simultaneously with self-report measures. According to Podsakoff and Organ (1986), Harmon's one-factor test was recommended to assess CMB. The result showed that the first factor accounted for only 31.6% of the overall variance, indicating that no single factor could significantly influence the overall variance of the model. In addition, according to Pavlou (2005), the CMB will affect the data validity when the correlation coefficient among constructs exceeds 0.9. Table 3 shows that the correlation coefficient between any two latent variables is less than 0.9, suggesting that CMB is not a significant problem for this work.

TABLE 4 Results of confirmatory factor analysis.

	Average	Standard deviation	Loading
a1	4.95	0.83	0.81
a2	5.23	1.04	0.85
a3	4.52	0.80	0.89
a4	4.87	0.94	0.90
a5	4.30	0.88	0.82
b1	4.41	1.12	0.86
b2	4.52	0.95	0.85
b3	5.01	0.99	0.80
c1	4.66	0.82	0.92
c2	4.78	0.85	0.88
c3	4.36	0.97	0.82
d1	5.19	0.83	0.91
d2	4.84	0.81	0.88
d3	4.27	1.09	0.85
e1	5.36	0.82	0.87
e2	4.80	0.92	0.83
e3	4.35	0.96	0.84
f1	4.96	0.89	0.84
f2	4.43	1.01	0.91
f3	3.89	1.17	0.85
g1	4.22	0.98	0.83
g2	3.87	0.93	0.87
g3	4.18	0.86	0.95
h1	4.81	1.08	0.82
h2	4.60	0.97	0.93
h3	5.07	0.83	0.87
h4	4.56	1.03	0.89

5. Results

We adopted a bootstrap method to analyze the significance of each variable path and the structural equation's explanatory power. The goal is to gain insights into the effect of each potential factor on teachers' satisfaction and performance in online teaching. The bootstrap method used a repeated sampling of valid sample data for statistical analysis, with a sample size of 500. The structural equation modeling results are shown in Figure 2.

5.1. Teachers' performance and attitude toward online teaching

The results showed that teachers' online teaching satisfaction significantly affected their performance during the COVID-19 pandemic, suggesting that hypothesis 1 is supported.

The regression model revealed that teachers' perceived usefulness and ease of use of online teaching significantly had positive effects on their online teaching performance, which supported hypotheses 2 and 3. Additionally, the contribution of perceived ease of use of online teaching to teachers' performance was more significant than that of perceived usefulness.

The regression model has shown that the teachers' perceived ease of use and usefulness in online teaching significantly has a positive effect on their online teaching satisfaction. Hypotheses 4 and 5 have been supported. Additionally, the contribution of perceived ease of use to teachers' satisfaction was more significant than that of perceived usefulness.

5.2. Expectation confirmation and online teaching satisfaction

Regarding expectation confirmation, the regression model analysis revealed that confirmation of teachers' expectations for the teaching goals and classroom interaction had a significant effect on online teaching's perceived usefulness. These results supported hypotheses 6, and 8.

The effect of confirmation of students' satisfaction on perceived usefulness was not significant; thus, hypothesis 10 was not supported.

Furthermore, teachers' expectations confirmation of the achievement of teaching goals and classroom interaction significantly affects teaching satisfaction, which supported hypotheses 7, 9.

The effect of expectation confirmation of students' satisfaction on teachers' online teaching satisfaction was not significant; thus, hypothesis 11 was not supported.

5.3. CSE and online teaching satisfaction

Based on the CSE factor analysis, the regression model showed that the effect of teachers' CSE on perceived ease of use was not significant. Thus, hypothesis 12 was not supported. However, CSE had a significant effect on teachers' online teaching satisfaction, which supported hypothesis 13. Additionally, we measured the explanatory power of the model using R-Squared (R^2). The R^2 for teachers' performance and teachers' satisfaction were 0.0619 and 0.525, respectively, showing that performance and satisfaction had 61.9 and 52.5% of the variance in teachers' online teaching behavior. Thus, the research model explained most of the variance in teachers' performance in online teaching, revealing that the model had strong explanatory power.

5.4. Evaluating control variables

one-way ANOVA has been applied to examine the effects of control variables (i.e., gender and teaching year) on teachers' online teaching performance (Panigrahi et al., 2021), and the results revealed that there were no significant differences in teaching performance in different gender and teaching year groups (both $p > 0.1$). These findings suggest that the effects of the control variables are insignificant.

6. Discussion

6.1. Major findings

This study uses a model that integrates TAM with ECM and CSE to analyze the influencing mechanism of online teaching satisfaction and performance of Chinese university teachers during the COVID-19 epidemic. We obtained some findings after the regression analysis.

First, the empirical results confirm that teacher satisfaction, teachers' perceived usefulness to online teaching, and perceived ease of use are positively correlated with teachers' online teaching performance. Typically, job satisfaction affects job performance, implying a relationship between morale and productivity. Higher morale improves productivity (Strauss, 1968). Thus, studies believe that a positive assessment of an attitude object predisposes people to engage in positive behaviors (Dewaele, 2019; Donehower Paul et al., 2020). Conversely, an unfavorable evaluation can predispose an individual to hinder or oppose this behavior (Eagly and Chaiken, 1993; Dunn et al., 2018). Judge et al. (2001) conducted meta-analytic reviews of 1,008 studies on the relationship between job satisfaction and job performance; they found that the mean accurate correlation of these two factors was moderate (0.30), which suggests that satisfaction may not exert effects on job performance. Fortunately, our empirical results demonstrate that a correlation exists in online teaching. Teachers' online teaching satisfaction has a significant impact on teachers' online teaching performance. Therefore, the quality of online education is vital, and it is pivotal to adopt measures to improve teachers' online teaching satisfaction.

Second, our results confirmed a positive correlation between teachers' perceived ease of use, perceived usefulness, and teacher performance in online teaching. Perceived ease of use has a more significant impact on teacher performance. This result is consistent with the results presented by Zhu et al. (2022). They found that teachers who demonstrated high performance in online teaching had higher adaptability to online teaching and a higher ability in using online teaching tools. This adaptability and knowledge can make teachers feel confident and calm about online teaching. Additionally, a rich online teaching experience can help teachers organize online teaching effectively and enhance online teaching performance. As we presume, teachers can improve their online teaching performance and guarantee the quality of online teaching if they receive trusted teaching support and technical support.

Our research also shows that teachers' perceived usefulness and ease of use in online teaching positively influence teachers' satisfaction with online teaching. This result is consistent with the findings presented by previous studies regarding teachers' online teaching satisfaction (Tan and Shao, 2015; Bajaj et al., 2021).

Additionally, the findings underscore the critical role of perceived ease of use in achieving teacher satisfaction, revealing teachers' convenience in online teaching may arouse their intention. This strategy has more weight than making teachers understand the value

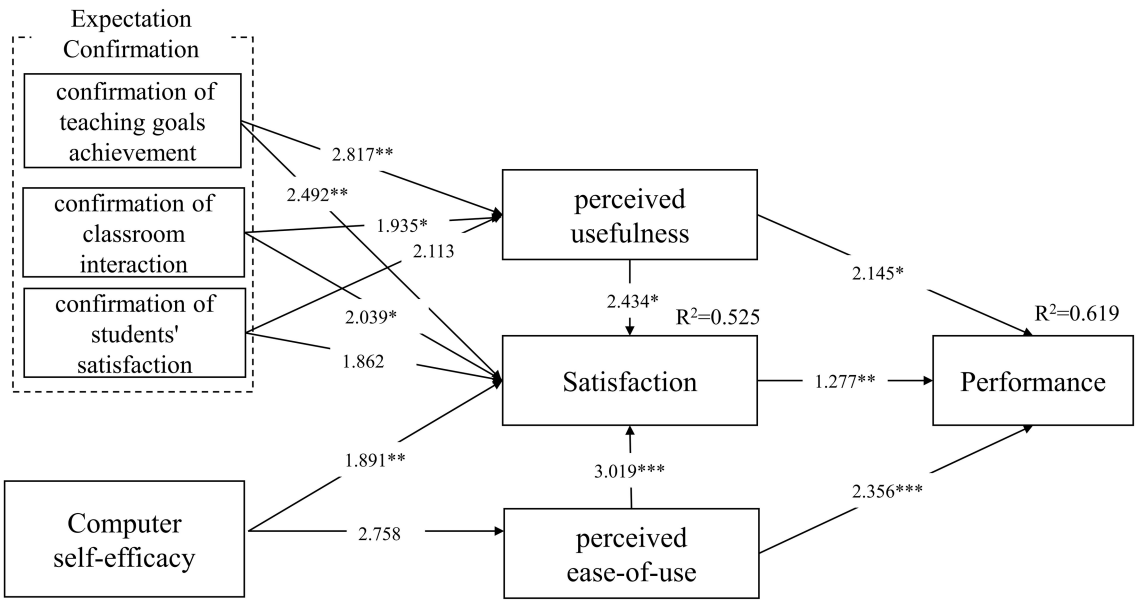

FIGURE 2
Structural equation modeling results. *$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

of online teaching and students' academic achievement. Sharma and Saini (2022) also found that teachers' perception of the ease of use of online teaching affects teachers' continued usage of online education. Although they did not explore the relationships between perceived usefulness and teacher satisfaction, their findings expressed teachers' attitudes to a certain extent.

Some interesting findings were recorded when analyzing the relationship between expectation validation, perceived usefulness, and satisfaction. The regression model analysis showed that the hypothesis "Confirmation of teaching goal achievement and online classroom interaction have positive effects on perceived usefulness" was supported. However, hypothesis 10 is not supported. This result is contrary to the existing research on teaching quality (Greimel-Fuhrmann and Geyer, 2003; Song et al., 2016). Generally, student feedback is a vital source for teachers to evaluate their teaching performance, which thereby affects their emotions. Teachers will be confident in their teaching performance when students are active in the classroom (Shoepe et al., 2020). One possible explanation is that a public health emergency could cause schools and teachers to be unprepared when faced with online instruction. While teachers use enormous energy to complete online teaching tasks according to the requirements and regulations, they may still face challenges in paying attention to student feedback. At the same time, online teaching has inherent shortcomings in the perception of students' attitude feedback. For example, it is difficult for teachers to observe students' expressions, movements, and other feedback behaviors, which may be possible in face-to-face teaching. Perhaps when they first implemented online teaching in 2020, teachers paid more attention to whether students were satisfied with the quality of their online education. Despite the limitations of attitude feedback in online teaching, teachers have implemented unprepared online teaching many times within three years, and they have become accustomed to the problems, such as low attitude feedback from students. This situation deserves our vigilance. Some objective factors make teachers no longer pay attention to students' feelings when engaging in online teaching, which deviates teachers' grasp of students' learning status and thereby affects the quality of online teaching.

In addition, the reduction of social presence due to space–time barriers and the difficulty of teacher-student interaction has been proved by many studies to be a significant problem affecting online teaching (Gopal et al., 2021). Our results confirm that teachers' expectations of effective teacher-student interaction significantly impact teachers' perception of online teaching and satisfaction. This shows that teachers should pay more attention to online teaching design and develop more classroom interaction activities. Teachers should provide more opportunities for interacting with students. They should develop a strategy to combat loneliness and helplessness to improve online teaching efficiency.

Our results also reveal the relational analysis of teachers' computer self-efficacy on perceived ease of use and satisfaction. Generally, the higher the user's computer self-efficacy level, the more likely they feel comfortable with the new e-learning method (Katsarou, 2021). However, our results demonstrated that teachers' computer self-efficacy did not significantly impact their ease of use in online teaching. Teo et al. (2018) also have found that teachers' computer self-efficacy cannot support ease of use. They explained that even if the teachers were competent enough to accomplish the teaching task through technology, they could still perceive such an effort as laborious. Combined with the characteristics of online teaching during the pandemic, even if teachers are confident in using online technology, they may still perceive online teaching as challenging to implement. Nevertheless, the relationship between teachers' computer self-efficacy and satisfaction shows that as teachers become more skilled in online teaching, they can solve more issues they meet during teaching, which may enhance their satisfaction with online education. Therefore, more training is vital for teachers to use online teaching platforms and tools.

6.2. Theoretical and practical implications

This study contributes to the research on teachers' satisfaction and performance in the context of online teaching in several aspects. First, our study contributes to the online teaching literature and provides opinions regarding how teachers' online teaching performance can be improved. Given that little empirical research has been previously conducted to explain the relationship between teachers' online teaching satisfaction and performance, we explore the factors influencing the satisfaction and performance of teachers for online teaching behavior by proposing an integrated research model (Panisoara et al., 2020). Our results empirically confirmed that teachers' satisfaction, perceived usefulness, and perceived ease of use of online teaching significantly influence their online teaching performance, thereby providing a framework for future studies to examine the precursors of teachers' online teaching performance from a usage intention perspective (Sulistiyani and Nugroho, 2022). Meanwhile, the findings reveal that perceived ease of use significantly impacts teacher performance more than perceived usefulness, confirming the pivotal effects of teachers' familiarity with online teaching technology on online teaching quality. The results also reveal that the relationship between CSE and perceived ease of use is insignificant. Thus, our study provides a possible direction for further research to investigate whether other factors (e.g., quality factors) have predictable effects on teachers' perceived ease of use of online teaching.

Second, while researchers have acknowledged the influence of teachers' perceived usefulness and ease of use of online teaching on their satisfaction, few of them have discussed such a relationship exists in an emergency like the one that occurred with COVID-19. To address this research gap, our study applied TAM, ECM, and CSE models to explore the predictors of teachers' satisfaction with online teaching during COVID-19. The results underscore the critical role of perceived ease of use in achieving teacher satisfaction. This finding suggests that a friendly and easy-of-use online teaching platform may be the precondition for teachers to participate in online teaching. Given our work under the COVID-19 context, with many teachers teaching online without sufficient preparation, our findings may enlighten the research on the large-scale application of online teaching.

Third, this study broadens the application of TAM. Our work is the first research to utilize TAM to explore teachers' online teaching performance as far as we know. Quite a bit of research on usage intention adopted this model to examine teachers' and students' satisfaction and usage intention on classroom IT applications; therefore, it is a practical theory to explain an individual's behavioral intention. We adopted TAM to explore teachers' online teaching performance can be a valuable theoretical foundation based on empirical results. Given that our research model has been proven to be strong explanatory power of teachers' online teaching satisfaction and performance during COVID-19, we may confirm its applicability in the educational context. This model provides an alternative theoretical framework for future research on teachers' online teaching performance. Further studies incorporating more predictors and extending to the typical types of online teaching may reveal more results on the development of teachers' online teaching performance.

Our study also provides school administrators and technology providers with practical implications for improving online teaching quality.

First, the results confirm the predictable effects of teachers' online teaching satisfaction on teachers' performance. In particular, the findings verify that perceived ease of use exerted a more substantial impact on teachers' online teaching performance than other variables, which underscored the dominant role of technical convenience (e.g., friendly technical platform, adequate specialized training, timely technical support) in the formation of teachers' performance. Therefore, school administrators should organize training on online teaching applications, operation guides, and teaching models to improve teachers' familiarity with online teaching platforms and tools and improve teachers' online teaching capabilities. Meanwhile, to reduce the difficulty of using the online teaching platform and improve teachers' usage satisfaction, technology providers are expected to implement more measures to provide timelier response mechanisms in the event of online teaching problems, more concise interactive interfaces, and more straightforward operation procedures.

Second, we found that confirmation of teaching goal achievement and online classroom interaction significantly affect teachers' perceived usefulness of online teaching. This finding is consistent with previous research on teacher satisfaction with online education (Hampton et al., 2020; Huang et al., 2022). It suggests that school administrators should assist teachers in developing teaching plans calendars before implementing online teaching and clarifying the specific goals of each lesson (Sims and Baker, 2021). Moreover, they can organize training for highly interactive teaching tools to help teachers acquire interactive online teaching skills.

Third, as the effects of confirmation of student satisfaction cannot influence teachers' perception and satisfaction with online teaching usefulness, the unexpected result should attract the attention of researchers and practitioners. As teachers seemed not to care about students' feedback regarding the teaching quality and ignored the rigorous and systematic design of remote teaching and learning, we wonder if they just took online teaching as a temporary alternative to cope with the teaching task during the epidemic. School administrators should take decisive measures, such as strengthening the monitoring of teachers' online teaching process, and using more flexible methods to obtain feedback on teachers' online teaching, to guarantee the quality of online education.

7. Conclusion

This study uses the integrated model of TAM, ECM, and CSE to investigate factors influencing Chinese university teachers' satisfaction and online teaching performance. Since few studies systematically examine teacher satisfaction and performance, we explored this area from an integrative perspective. The results show that teachers' satisfaction with online teaching has a significant impact on teachers' online teaching performance, which provides a conditional basis for teaching reform and for enhancing the quality of online education and teacher satisfaction. In perceived ease of use and perceived usefulness, we have found that teachers are more aware of the satisfaction in ease of use. In addition, teachers' perception of usefulness and satisfaction with online teaching is mainly on whether online teaching can

effectively achieve teaching goals and whether effective classroom interaction is available during the teaching process. However, students' attitudes and their feedback on courses and teachers did not affect teachers' perspectives on the usefulness of online teaching. Possible constraints in the online teaching task and computer self-efficacy were predictors of teachers' online teaching satisfaction but did not affect their perception of the ease of use of online teaching. Our findings will enrich the literature on teachers' online teaching performance and increase our understanding of the antecedents of teachers' online teaching satisfaction. Our findings will also assist school administrators and technology providers to improve their teaching support and technology tool systems.

8. Limitations

Two limitations found in our study are as follows: First, the sampled universities are all from developed cities, such as Shanghai. Therefore, the quality of network equipment and online teaching platform tools is best guaranteed in these cities. We are uncertain whether network equipment quality factors contribute to teacher satisfaction. Second, we did not specifically consider the impact of different knowledge types on teachers' online teaching satisfaction and performance. Perhaps online teaching in theoretical courses is more accessible than online teaching in practical knowledge. However, we have not yet verified this with empirical data. Future research can improve this by analyzing the different courses in the same subject area.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

WD, LW, and RL discussed the research ideas, research methods, and framework of the article. Specifically, WD is mainly responsible for conceptualization, literature review, and discussion. JZ is responsible for discussion. LW and RL are responsible for data collection, data analysis, and the conclusion section. WD and RL are responsible for initial draft preparation. WD, LW, and JZ are responsible for revision and editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The necessary, albeit belated, transition to computerized cognitive assessment

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Cognitive assessment is a common and daily process in educational, clinical, or research settings, among others. Currently, most professionals use classic pencil-and-paper screenings, tests, and assessment batteries. However, as the SARS-CoV-2 health crisis has shown, the pencil-and-paper format is becoming increasingly outdated and it is necessary to transition to new technologies, using computerized cognitive assessments (CCA). This article discusses the advantages, disadvantages, and implications of this necessary transition that professionals should face in the immediate future, and encourages careful adoption of this change to ensure a smooth transition.

KEYWORDS

cognitive assessment, cognition, digital tools, computerized cognitive assessment, paper and pencil test

1. Introduction: the current state of cognitive assessment

Cognitive assessment refers to a set of techniques and procedures to ascertain the status of one or more aspects of a person's cognitive profile. It is an essential process that is performed daily in clinical, academic, and research settings around the world. It is often used to identify behavioral markers of processes involving cognitive impairment (Wild et al., 2008) or neurodegeneration (Choi, 2008; Davis et al., 2015; Daroische et al., 2021), although it is also used in healthy users (White et al., 2012; Bertelli et al., 2018). These tests can take many forms, consist of different activities, have different application rules, and require different types of answers from the user. However, to a greater or lesser extent, they can all be applied in different formats, the main versions being paper-and-pencil and computerized.

Mainly for reasons of tradition and accessibility, most of the widely applied tests are paper-and-pencil tests. Classical examples include the Montreal Cognitive Assessment (MoCA; Nasreddine et al., 2005), the Stroop Test (Stroop, 1935), Raven's progressive matrices (RSPM; Raven, 1938), Rey Auditory Verbal Learning Test (RAVLT; Rey, 1941; Schmidt, 1996), Trail Making Test (TMT; Reitan, 1955), the Corsi Block-Tapping Test (Corsi, 1972), the mini-mental state examination (MMSE; Folstein et al., 1975), Wisconsin Card Sorting Test (WCST; Heaton, 1981), Boston Naming Test (Kaplan et al., 1983), and the Wechsler scales (Wechsler, 2008; Wechsler, 2014). While quite a few of these individual tests have been digitized (Hannukkala et al., 2020), most of the assessment batteries that usually contain them have not finished making the step into the digital modality, only timidly entering the field through digitized corrections, without coming fully online. In addition, it should be noted that there is a relatively wide range of variability in the digitalization feasibility of the tests. On the one hand, the translation to digital format is straightforward for tests that require selecting one or more answers from an

array of options on paper. On the other hand, tests that are manipulative or visuo-constructive, or that require drawing or complex verbal responses, represent a challenge or imply complex adaptation processes for their implementation on digital devices.

In contrast, more recently developed tests and assessment batteries are now being created fully digitized, to the point that some of them have not even been distributed in physical format. These are generally called computerized cognitive assessments (CCA), and some of the most noteworthy examples include the CogniFit General Cognitive Assessment Battery (CAB)™ (Haimov et al., 2008), or the Cambridge Neuropsychological Test Automated Battery (Sandberg, 2011), in addition to those that Zygouris and Tsolaki (2014) already pointed out in their review. This article outlines the advantages, disadvantages and implications of this transition to digital.

2. Reasons for the transition

Before the 2000s, it did not make sense to use digitized tests, because of the cumbersome, expensive and infrequent equipment required. However, nowadays children are educated in the use of technology (Lee et al., 2014; Wojcik et al., 2022), adults work with it every day, and older people are gaining experience and confidence in the use of these devices (Demiris et al., 2004; Kim and Preis, 2015; Kim et al., 2016). Thus, technological advances and easier access to technology have made CCAs feasible for everyday use.

The transition to CCAs is supported by different cognitive theories and psychometric approaches. For instance, computer-based assessments allow customizing the tests to the test-takers along the principles of the Item Response Theory (Mead and Drasgow, 1993; Huebner, 2010). Besides, the Cognitive Load Theory (Sweller, 1988) suggests that the computer-based format decreases ineffective cognitive load with respect to the paper-based format, thus optimizing performance (Khalil et al., 2010; for further discussion, see Taylor 1994).

Given this paradigm shift, it seems reasonable to foster a transition to the coexistence between classic cognitive assessment tools and CCA to always offer the option that best fits the circumstances of each evaluation session, evaluator, and person being assessed. The greatest example of the need to implement CCA as a regular tool and that classical tests can become non-operational has been unintendedly offered by the lockdown resulting from the SARS-CoV-2 health crisis (Larner, 2021). Many health and education professionals, and researchers who needed to assess the cognitive status of their informants have had to either pause their activity or migrate to new technologies because the classic cognitive assessment tools they used to apply were no longer suited to the needs of the situation. In fact, these circumstances have changed the modality of assessment, but not the frequency with which they are used (Webb et al., 2021). With this in mind, a selected literature review of the status and needs in the field of cognitive assessment has been conducted, and the pros and cons of transitioning to CCAs have been analyzed.

3. The advantages of CCA

Numerous studies address the advantages of computerized cognitive assessments over classic pencil-and-paper tests (Sternin et al., 2019). The most basic advantage is familiarity with the delivering device since digital technology is deeply integrated into our lives. Most people not only make use of computers, tablets, and smartphones daily, but also master these devices.

Digital platforms are also well-known for their accessibility, and the possibility of modifying the contrast, the size or color of the text, the volume, or the response requirements of people with reduced mobility or motor difficulties represent altogether a clear-cut advantage of CCA. The adaptation of the test to the specific needs of the assessed person is straightforward in CCA, including language modification when it is necessary to serve a student, patient, or user of another language (see Frances et al., 2020, for a discussion of the impact of this factor). Since COVID-19, ubiquity takes an important role, and the need to remotely assess people has skyrocketed (Larner, 2021). In this line, several studies point to the feasibility of remote cognitive assessments (Settle et al., 2015; Geddes et al., 2020; Zeghari et al., 2021).

Usability and user experience can also be taken as a clear advantage of CCA over traditional assessments. Interactive activities, automatic visual and auditory feedback, and colorful stimuli result in more engaging, motivating, and user-friendly assessments for the test-taker and are easier for the evaluator (Soto-Ruiz, 2020). But importantly, the CCA does not have to lose psychometric value because of their customizable digitized format. In fact, psychometric characteristics such as discriminant validity or test–retest reliability of CCAs are usually well documented, as in the case of conventional paper-and-pencil resources (Zygouris and Tsolaki, 2014). In fact, the ability of the device itself to record reaction times, to be extremely accurate in identifying user responses, to provide the same feedback to all users equally, to provide instant results, or to support the incorporation of more sophisticated techniques such as eye movement detection, are some of the major advantages of CCA.

Another advantage that may not be as obvious, but that stands as a critical one, is the updateable nature of the scales. If test distributors regularly update the reference scales of test scores, there is no need to buy new versions of the test to stop comparing test takers with outdated scales. This is a relatively natural process for the CCA given that the update may take place in a server, without imposing any burden on the evaluator. In contrast, any update in the reference norms of a paper-and-pencil may require renewal actions on the side of the evaluator.

4. In the way to transition

What keeps professionals attached to cognitive analog assessments? The CCA have some limitations that cannot be ignored and that will make it preferable on certain occasions to use analog tools instead of digital ones. There are still people who are digital illiterates or that have a low technological-digital command, and they may manage well or better with paper and pencil. This may be particularly important in certain pathologies, and as Witt et al. (2013) pointed out, the CCA cannot completely replace a comprehensive paper-and-pencil neuropsychological assessment in certain circumstances.

However, one of the main problems that prevents professionals from making the transition is more contextual and cultural. On the one hand, professionals are habituated to using analog screenings,

tests, and cognitive assessment batteries. They have been historically trained with them, they have applied them hundreds of times and any change to a digital tool can be cumbersome. On the other hand, the prior investment of a professional needs to be considered. If professionals have spent large sums of money on analog assessment batteries, it is expected that they will be reluctant to change until the redemption of the investment is effective.

Besides, it should also be considered that access to the Internet is most of the time a mandatory technical requirement of the CCA. While there is usually a fast and stable Internet connection in urban spaces, there are places where the connection does not allow for assessments that require heavy or agile data transfer (Gerli and Whalley, 2021). The same happens with access to electricity, which is not always stable or possible, limiting access to this type of test. In addition, there is another critical aspect related to the specific testing conditions that must be taken into account when assessing remotely. Most tests are intended to be applied in laboratory-like clinical settings, with good control of potentially interfering environment-related factors (Robillard et al., 2018). When a person performs the assessment from home without being under the guidance of a professional, the chances increase that uncontrolled environmental conditions could interfere with the process (e.g., distractions, facilitations, or other elements that may affect the validity of the assessment). For this reason, a correct CCA necessarily implies advising about the necessity to prepare and secure the environment and conditions in which the assessment is to be performed and implementing mechanisms to assess the validity of the data.

In a broader sense, it should also be noted that not all tests need to be directly translated into a digital format, and that some if not all will require some adaptations or modifications. In these circumstances, it becomes especially important to ensure the psychometric qualities of CCA (Gates and Kochan, 2015) and to develop adequate quality assurance tests. Furthermore, all the modifications need to be endorsed by scientific evidence, similar to the procedure being currently developed to adapt classic laboratory 2D assessments to 3D virtual reality assessments (see Rocabado and Duñabeitia, 2022).

5. Discussion: implications of these changes

Health measures such as the lockdowns adopted during the COVID-19 pandemic have made the importance of CCA clear (Hsu et al., 2021). Nowadays digital tools are integrated into the daily life of professional and non-professional individuals at schools, healthcare centers, workplaces, and social contexts (Tomasik et al., 2020; Nordin et al., 2021; Paganin and Simbula, 2021). They are well-known and familiar tools for most users. The design and implementation of CCA based on these widespread digital tools could offer a better service to students, patients, or research participants, making the activities more attractive and dynamic, individualizing the tests, and updating the reference standards.

CCA is increasingly integrated into the daily lives of professionals and has a great and growing potential. Without sacrificing the quality of the tests, CCA allows for adapting assessment characteristics to the specific needs of the test-takers, increasing the accuracy of the measurements, assessing remotely on common devices available to a wide portion of society, and giving immediate and motivating feedback. However, CCA also has human limitations, such as users who are not proficient with digital tools or professionals who want to amortize the investment made in classic tests. Besides, certain environmental conditions may limit the degree of generalization of CCA, such as the need to have access to electricity and connectivity or the relative lack of control over the assessment environment. Thus, proper adaptations to digital format with good psychometric characteristics are essential to spread the use of CCA. Nevertheless, the transition to digital assessments is an inevitable evolution.

The debate is not about using only digitized tools or only classic tools, but about whether we are adapting classic paper-and-pencil tools to the context in which we live at the right speed. Classic assessment tools will and should continue being used for some time or, perhaps, always. But the migration to digital tools in parallel is indisputable, and it must be carried out thoroughly to facilitate professionals' work in case we meet again in such adverse circumstances where in-person paper-and-pencil assessments cannot be used.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

DA and JD contributed to the conceptualization. DA wrote the original draft. JD reviewed, edited the text, and supervised the project. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Evaluating gifted students' perceptions of the characteristics of their effective teachers

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Due to the special needs of gifted students, it is crucial that their teachers are carefully selected in order to give gifted students the greatest educational experience. The study involved 120 teachers from Saudi Arabia, Bahrain, and the United Arab Emirates along with 300 gifted students, both males ($n = 144$) and females ($n = 156$). Teachers of gifted students involved in the study were asked to complete the Preferred Teacher Characteristics Scale (PICS); additionally, teachers filled out a background questionnaire. While gifted students responded to three open-ended questions, The findings corroborated the idea that gifted students perform better in an environment where their teachers' personalities are evident. This finding was in line with the preferences of teachers as measured by the PCIS scale, which revealed that students tended to value teachers more for their personal characteristics than for their professional ones. Many personal characteristics were highly regarded by the gifted students, who in this study believed they contributed to a teacher's effectiveness. Personal integrity, tolerance, tenderness, friendliness, a sense of humor, and an openness to new experiences were among these characteristics.

KEYWORDS

gifted, effectiveness, professional characteristics, personal characteristics, gifted students' teachers

1. Introduction

The teacher is without a doubt the most important part of any educational program's success. In education, teacher efficiency has been related to a variety of affecting variables such as students' families' backgrounds and socioeconomic status (Berliner, 2006), as well as the educational authority (Tomlinson, 1998). Teachers' perceptions, attitudes, and beliefs have a significant influence on students' cognitive development (Lupascua et al., 2014). More than simply imparting knowledge, the teacher is also responsible for training and qualifying students to meet society's various demands and to take part in its advancement by overcoming the problems and obstacles that impede growth and progress. As a result, every study of gifted students and their treatment has emphasized the need for the teacher to have a set of professional, social, and personal characteristics (Mahfouz, 2015). Individual teachers had the greatest impact on student progress, according to recent studies using multilevel modeling techniques (Goldstein, 2003). Berliner (1986) also pointed out that evaluating effective teachers is necessary to get a better understanding of how to effectively teach students. In a survey of twenty-one gifted education professionals, Renzulli (1968) found that the teacher was the most important factor in the success of gifted programs. Knowing what makes a really good teacher can benefit teachers both now and in the future in the classroom. Brown and McIntyre (1993) suggested that we consider the perspectives of students in the classroom and the literature on the characteristics of effective teachers when

considering the craft of good teaching from an unbiased perspective that is not based on previous assumptions or models of what effective teaching requires (Brown and McIntyre, 1993; Su, 2006). In fact, in many studies, gifted students' perceptions have been utilized to identify effective teachers (Berliner, 1986; Brown and McIntyre, 1993; Su, 2006; Kornelia and Wilhelmina, 2009). By taking into account the preferences of gifted students as part of the educational process, teachers and school administrators can boost the achievement and motivation of gifted students (Chae and Gentry, 2011). The needs of gifted students should be understood by school administrators and teachers; otherwise, these individuals may become disinterested in learning, develop poor study habits, and exhibit behavioral issues. One of the biggest factors is how teachers act, which can stop students from getting better and concentrating on their lessons (Hosgorur and Gecer, 2012). It is possible that the discrepancy between what gifted students prefer for the traits of their teachers and what teachers think their gifted students might prefer for their teachers can create a less-than-ideal learning environment, given insights that emerge from analysis of data from various studies (Su, 2006; Kornelia and Wilhelmina, 2009; Leavitt and Geake, 2009; Mahfouz, 2015; Burstow, 2018; Yasar, 2018). That posit that learning the largest occurs when students are in a learning environment where their preferred teacher behavior matches the teacher's attributes. According to these studies, gifted students' teachers need to have a good understanding of the needs of gifted students so that they can achieve a balance of personal and professional characteristics that is more in line with students' preferences.

The student perspective is critical since, aside from their teachers, students are the only ones who are aware of how lessons are done regularly (Cooper and Mcintyre, 1996; Gargani and Strong, 2014; Johnsen, 2021). Students will have had exposure to a range of teachers, teaching methods, and techniques by the time they reach high school, giving them a wealth of comparison data from which to choose. While the general literature on teacher effectiveness may define effective teaching as fostering students' affective and personal development besides curriculum mastery, the literature on gifted education may recognize the need to foster gifted students' specific affective and personal development, with an emphasis on fostering gifted students' particular aptitudes, possibly beyond the usual measures of curriculum mastery (The Arab Center for Educational Research for the Gulf States, 2020; Education and Training Evaluation Commission, 2022). According to studies done, more emphasis should be placed on adapting teaching and education methods to the needs of gifted students to prevent underachievement (Benbow and Stanley, 1996; Rimm, 1997; Gross, 1999).

2. Study problem

There appears to be a new drive in gifted education to investigate the impact that teachers can have on gifted students, particularly to assist them in developing and succeeding at the high levels that are expected of them. Despite the popular belief that gifted students can achieve academic success without the help of their teachers or the attention of their schools (Gross, 1999; Şahin and Çetinkaya, 2015; Burstow, 2018), many studies show how this group is affected by a lack of care, educational neglect, and disinterest (Su, 2006; Kornelia and Wilhelmina, 2009; Aboud, 2020; Alamiri, 2020). According to Gagné (2003), "giftedness" is defined as a high level of achievement or performance (within at least the upper 10% of age peers in the relevant fields). He merely asserts that, while giftedness requires attention to develop, being gifted itself does not guarantee that giftedness will develop. Environmental factors, such as the quality of gifted school education, he claims, act as accelerators for the development of giftedness. This does not eliminate the need to improve teacher efficiency. As a result, gifted education literature may better comprehend the goal of supporting gifted students' outstanding effectiveness and personal growth (Aljughaiman, 2010; Aljughaiman et al., 2016; Worrell et al., 2019; Alamiri, 2020). The study's critical question is: why are certain teachers more effective than others at teaching certain students, particularly gifted students? What characteristics differentiate effective teachers of gifted students from others? Teachers promote the academic and intellectual development of the students they teach. Each teacher is a unique individual with a different personality, life experiences, and worldwide perspective (Al-Anzi, 2006; Colangelo and Davis, 2008). Some argue that teachers who are highly effective with one group of students may not be as effective with other groups (Mills, 2003). By examining the agreement between gifted students' perceptions of their gifted teachers and the teachers' perceptions of what their students may appreciate about the effective characteristics of their teachers, the current study sought to determine whether the characteristics of teachers who work with gifted students differ significantly in Saudi Arabia, Bahrain, and the United Arab Emirates. Additionally, the findings of the qualitative data were obtained from three open-ended questions. The gifted students were given the following questions to answer: (1) What makes a teacher effective? (2) What professional characteristics do you believe make a teacher effective? (3) What personal characteristics do you believe make a good teacher?

3. Characteristics of effective gifted teachers

Because of the unique nature of gifted students, their teachers must be chosen carefully to ensure that gifted students have the best possible educational experience. Many categories of desirable characteristics in teachers of the gifted can be found in the literature, which can be divided into personal characteristics and professional characteristics. Capabilities, behaviors, attitudes, beliefs, personal characteristics, and knowledge are often included in these aspects of teacher personalities. The perceived benefits of the two proposed categories in training and selection are one rationale for employing them. Su (2006) argues that while personal characteristics can be chosen for, they are more difficult to modify than professional competence, which can be taught and acquired more easily through training. Whitton (1997) reported in her study of New South Wales primary school teachers they lacked comprehension of gifted students and made only minor adjustments to their teaching for them, which she attributed to a lack of teacher training. As a result, it makes sense to recognize the professional qualities that should be incorporated into teacher training. Teachers' education can impact personal characteristics, such as modifying teachers' attitudes regarding gifted students and how to meet their needs (Hansen and Feldhusen, 1994; Mahfouz, 2015). It's important to remember that developing certain professional skills can help you develop certain personal characteristics, and vice versa, so treating them as two distinct categories might mislead you (Su, 2006). Effective teachers of gifted

students, according to Ferrell et al. (1988), have unique teaching styles and are more motivated in the classroom than successful classroom teachers. Effective teachers, according to Lupascua et al. (2014), have clarity about their educational goals, are conversant with educational and training content, have good communication skills, and continually monitor their students' understanding. They seek to improve and support their teaching methods. Mills' study results show that certification and formal training in gifted and talented education may not be enough to consider when selecting teachers for gifted students. Instead, selecting teachers with strong experience in the academic discipline being taught, as well as those who have a passion for the subject, may be equally crucial. This is beside their knowledge (2003).

4. Definition of key terms

4.1. Gifted student

The Saudi Arabian Ministry of Education has expanded the definition of a "gifted student," defining it as a student who excels above the rest of their peers in one or more of the areas valued by society, particularly in the areas of mental excellence, academic achievement, creativity and innovation, and special skills and abilities, and who is chosen based on the relevant scientific bases (Aljughaiman et al., 2009).

4.2. Effective teacher

An effective teacher is able to differentiate levels for each student and engage all pupils through a range of educational delivery methods. They are qualified to assess students and possess the content expertise to teach. Through effective classroom management, effective teachers can foster learning environments. Additionally, they exhibit character traits that communicate their concern for students (Stronge et al., 2011).

5. Methods

5.1. Participants

Participants were gifted students attending academically selective schools in three countries: Saudi Arabia, Bahrain, and the Emirate. Table 1 shows sample characteristics. This study also includes teachers who have worked in gifted schools. There was no attempt to link teachers and students in the study by design; these teachers were chosen at random from gifted students' schools. 120 teachers were chosen at random from three countries: Saudi Arabia, Bahrain, and the United Arab Emirates. The average age of the teachers was 35.4 (SD = 12.0), with a range of 25–60. Male teachers accounted for roughly 44% of the teaching staff. These outstanding educators had an average of slightly over 4 years of experience teaching gifted children and over 8 years of interacting with gifted students. Half of the teachers reported having never taken a gifted education course before. Table 2 describes the demographic and background data for gifted teachers.

5.2. Instrument

Teachers of gifted students were given a questionnaire that contained some demographic and background data about themselves (gender, age, major in college, highest degree gotten, years of working with gifted students, and several gifted education courses taken). Also, teachers were asked to respond to the Preferred Teacher Characteristics Scale—Teacher Form (PICS). The amount of personal-social or cognitive-intellectual preference was assessed using the Krumboltz and Farquhar (1957) Preferred Teacher Characteristics Scale (PICS). The instrument consists of 36 items, each with two statements: one describing the personal-social behavior of the teacher and the other describing the cognitive-intellectual behavior of the teacher. The teacher form began with statements like, "I believe gifted students prefer a teacher who:" The PICS was given to the teachers who participated in this study. The teacher form's opening line read, "I feel gifted students prefer a teacher." Over a four-week period, the PICS authors reported a test–retest reliability coefficient of 0.88. An examination of the instrument's internal consistency revealed a reliability coefficient of 0.90. The researcher modifies the Preferred Instructor Characteristics Scale (PICS) to Saudi in the current study. Using the KR-21 (Kuder–Richardson Formula 21) and Split-Half procedures, the study's dependability was assessed. When there are only two possible responses to a question, the KR-21 test is applied (Hosgorur and Gecer, 2012). The investigation determined the split-half reliability coefficient, using the Spearman and Brown formula, to be 0.86 and the KR 21 value to be 0.88. The scale was first translated into Arabic by two subject matter experts with strong English skills and then separately by three English language specialists. These five

TABLE 1 Shows sample characteristics.

	Grade 9		Grade 10		Grade 11		Total
	M	F	M	F	M	F	
Saudi Arabia	20 47.62%	22 52.38%	18 50%	18 50%	18 47.36%	20 50.63%	116
Bahrain	15 48.39%	16 51.61%	14 48.28%	15 51.72%	12 50%	12 50%	84
Emirate	16 47.06%	18 52.94%	15 46.87%	17 53.13%	16 47.06%	18 52.94%	100
total	51 17%	56 18.66%	47 15.6%	50 16.67%	46 15.3%	50 16.67%	300

TABLE 2 Demographic and background data for teachers of gifted students.

Gender	Male	53	44.16%
Major of college	Female	67	55.83%
	Education	50	41.66%
	Humanities	37	30.83%
	Science	13	10.83%
	Math	9	7.5%
	Gifted Education	11	9.16%
Age	Mean = 38.6	SD = 11.3	
Highest degree gotten	Bachelors	88	73.33%
	MA	12	10%
	Master	20	16.66%
Countries	Saudi Arabia	66	55%
	Bahrain	31	25.83%
	UAE	23	19.66%
Years of working with the gifted student	Mean = 7.7	SD = 9.2	
Number of gifted Education courses taken	None	60	50%
	1–3 Courses	55	45.83%
	4 and above	5	4.14%

academics then met to discuss any translational discrepancies and come to an agreement. In order to determine whether the items were understandable and obvious to the intended student age groups, the scale was then reviewed with 10 students (ages 14, 15, and 16). Three open-ended questions were posed to gifted students in order to gain a better understanding of their perspectives on effective teachers. The students were asked to describe in their own words the qualities that they felt made for good, effective, and ineffective teachers. The gifted students were given the following questions to answer: (1) What makes a teacher effective? (2) What professional characteristics do you believe make a teacher effective? (3) What personal characteristics do you believe make a good teacher?

5.3. Procedure

This study focused on the relationship between teachers and their students. This study looks at the personality traits, abilities, behaviors, and practices of effective teachers, namely the personal and professional characteristics that appear to be effective when applied to teaching gifted students, whether alone or in combination.

During the class time in the school's classrooms, participants were given three open-ended questions about the characteristics of effective gifted teachers. The researcher announced the purpose of the study. The study questions took roughly 20 min to complete. Because the questions were given in class, just a few students declined to take part, resulting in a 98% response rate. Students who took part in the study were told to take as much time as they needed to complete the questions. The responses to the three questions were then gathered and scored. The questionnaire for the teachers was sent to them through email. Only 120 of the 200 teachers who were given questionnaires responded. The directors of gifted centers in Saudi Arabia, Bahrain, and the UAE were approached, and their permission was secured to administer the student questions and teachers' questionnaires. In this study, teachers ($n = 120$) were instructed to complete the PICS, taking as much time as they believed was necessary. After that, the scales were gathered and scored. A score of zero showed a preference for the presentation of only personal-social characteristics, while a maximum score of 36 indicated a preference for the presentation of only cognitive-intellectual characteristics. The desire for demonstrated cognitive and intellectual characteristics increases with higher scores, but the preference for demonstrated personal and social characteristics increases with lower scores.

5.4. Study design

The goal of the current study was to identify the patterns of preference displayed by gifted students and their teachers in Saudi Arabia, Bahrain, and the UAE. To assess how gifted students rated the characteristics of their effective teachers, a second sample of gifted students from those three countries was also included. The researcher used the descriptive-analytical method to characterize the demographic information she collected from the teachers and their replies on the PICS scale, while the qualitative-analytical approach was employed to examine the open-ended questions.

5.5. Data analysis

The qualitative data presented in this study paints a more nuanced picture than the quantitative data. Mayring (2000, 7th edition) inductive category construction method for systematic analysis of qualitative data was applied to the analysis of the open-ended questions. With this method, initial categories based on the study materials had to be created, and they had to be altered based on the initial interpretation of the data. The two original categories were personal and professional characteristics. The data within these broad categories was used to create inductive categories, which were then honed and reduced before being reinserted into the broad categories. The revised framework was then used to interpret the entire collection of data, as shown in Figure 1. It would be of utmost importance within the framework of qualitative methods to create the aspects of interpretation and the categories as close to the material as possible and to formulate them in terms of the material. For qualitative analyses of the three open questions, percentages of each variable were used. Using *in-vivo* coding to analyze the data that resulted from the open-ended questions of gifted students. *In-vivo* coding was used to carry out the coding process, which resulted in the creation of categories and their corresponding codes. The classical content analysis focused on content analysis and coding of certain sections of the material to analyze the collected data, followed by the compilation of similar codes into groupings. The process of coding ensured that codes were obtained in all cases, that the distinction of content between codes was carried out, and that the frequency of each code (quantitative information) was clarified. The data processing and coding process is independently worked on by two

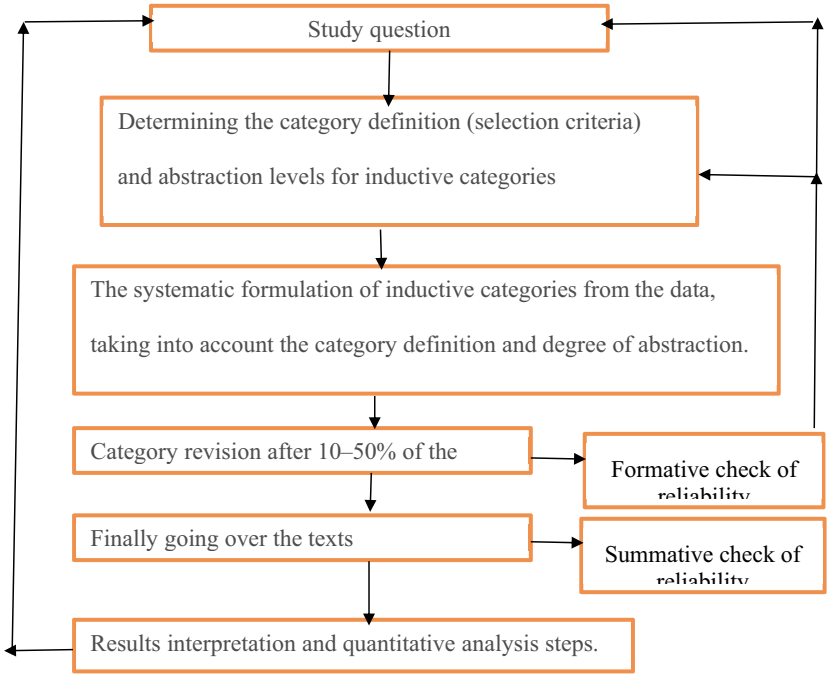

FIGURE 1
Step model of inductive category development (Mayring, 1994).

coders. The categories of responses and discrepancies were discussed in depth after completion, and after an agreement was reached, randomly selected interviews were coded by a third coder, who was generally aware of the main subject and fields of study. The degree of reliability appears to be acceptable for this study (88%).

The demographic information for teachers of gifted students and teachers' responses to PICS were analyzed quantitatively. According to the variables, the numbers were counted and percentages were calculated (gender, age, major of college, highest degree gotten, years of working with gifted students, and several gifted education courses taken).

6. Results

6.1. A PICS questionnaire

A PICS questionnaire is analyzed using a quantitative methodology. For each teacher, the 36 PICS items were totaled together, and a final score between 0 and 36 was obtained by subtracting 0 points for each personal characteristic and 1 point for each intellectual characteristic. The means and standard deviations were calculated using SPSS after the scores for each respondent were entered. As shown in Table 3, all three cohorts fall on the personal end of the continuum (Figure 2). Displayed teachers' continuum, indicating that teachers of gifted students in these countries place a premium on personal characteristics over academic ones. The Bahrain cohort exhibited a somewhat higher mean compared to the Saudi and UAE samples, which were very similar and fell in the bottom third of the continuum.

The data were subjected to an analysis of variance to see if there were gender or grade differences among the three cohorts (ANOVA).

TABLE 3 A comparison of means and standard deviations across three cohorts (Saudi Arabia, UAE and Bahrain).

	N	M	Std
Saudi Arabia	66	10.25	7.32
UAE	23	10.42	7.53
Bahrain	31	13.23	8.02

Table 4 shows that there were no gender differences in the Saudi and UAE samples, despite the fact that in both instances, female teachers had slightly higher positive attitudes regarding the personal characteristics than the male respondents. However, there was a significant difference between the genders in the Bahrain sample, with the men expressing a greater preference for personal characteristics than the women did ($F = 6.336$, $p < 0.05$).

There are significant differences for each of the three cohorts in Table 5 statistics on teachers by the grade levels they teach. Despite modest variations in the patterns between the three countries, teachers who work with younger students have the propensity to value personal characteristics more than those who work with older students. Teachers of grades 9 and 10 in the Saudi Arabian sample differ considerably from one another ($F = 11.013$, $p < 0.000$). Saudi teachers who teach in grades 9 and those who teach in grades 10 and 11 differ from one another ($F = 2.473$, $p < 0.05$). Between grade 9 and grade 10 teachers, there is a significant difference in the Bahrain sample ($F = 2.208$, $p < 0.000$).

6.1.1. What makes a teacher effective?

Based on the gifted students' responses to the open-ended questions, the researcher divided the primary characteristics shown

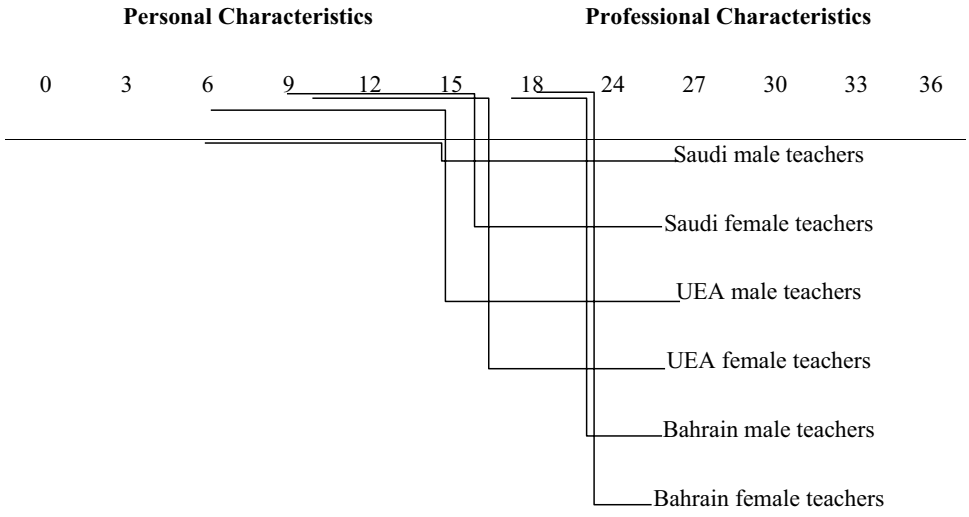

FIGURE 2
Displayed teachers continuum.

TABLE 4 A comparison of means and standard deviation across three cohorts (Saudi Arabia, UAE and Bahrain) according to teachers gender.

		N	M	Std
Saudi Arabia	M	30	10.22	7.28
	F	36	10.35	7.31
UAE	M	11	10.05	7.43
	F	12	10.25	7.55
Bahrain	M	15	13.11	8.00
	F	16	13.33	8.02

TABLE 5 A comparison of means and standard deviation across three cohorts (Saudi Arabia, UAE and Bahrain) according to teachers grades.

		Grade 9	Grade 10	Grade 11
Saudi Arabia	N	26	22	18
	M	8.33*	9.05*	13.02**
	Std	7.03	7.07	7.44
UAE	N	9	8	6
	M	7.86**	12.03**	11.97**
	Std	6.00	7.84	7.60
Bahrain	N	12	10	9
	M	13.02**	14.86	15.33
	Std	7.19	8.99	7.72

*$p < 0.05$; **$p < 0.001$.

by gifted students based on the most agreeable aspects they expressed about their teachers into two categories: personal and professional. The percentages of students who responded to an effective teacher's professional and personal characteristics are shown in Figure 3. Quick analysis of respondents' answers to the open-ended questions to isolate the key themes It's not unexpected that personal traits like friendliness and humor and social characteristics like listening to others and talking with them are important. However, a clear connection between the teachers' characteristics and their subject-matter expertise is also apparent in these open-ended responses. Many of the respondents made reference to the teachers' enthusiasm for their subjects and for teaching, and they emphasized the need for their instructors to be subject matter experts. The following comments were representative of the typical ones given by these students, who strongly preferred the personal characteristics of their teachers. As shown in Figure 3, most students' responses regarding what characteristics they perceive their teachers should possess to be effective were personal characteristics. The percentage of responses in both the male and female groups, grade groups, as well as country groups, revealed the dominance of personal characteristics. Female-gifted students favored professional characteristics more than male-gifted students. According to the results of the question analysis, students in higher grades were more likely than their older counterparts to favor their teachers' personal characteristics. Participants in the Saudi sample showed a slight preference for personal characteristics over those in the UAE and Bahrain, even though they had nearly equal preferences for personal and professional characteristics.

6.2. What professional characteristics do you believe make a teacher effective?

The researcher gathered the primary characteristics highlighted by gifted students as the most professional characteristics that make their teachers effective. Mayring (2000, 7th edition) inductive category construction method for systematic analysis of qualitative data was applied to the analysis of this open-ended question. The researcher next categorized the students' answers to their teachers' professional characteristics into particular subcategories, as shown in Table 6.

As indicated in Table 3, the perceptions of gifted students about their teachers' effective professional characteristics were classified into five major categories. Sub-categories emerge in each category. Most of

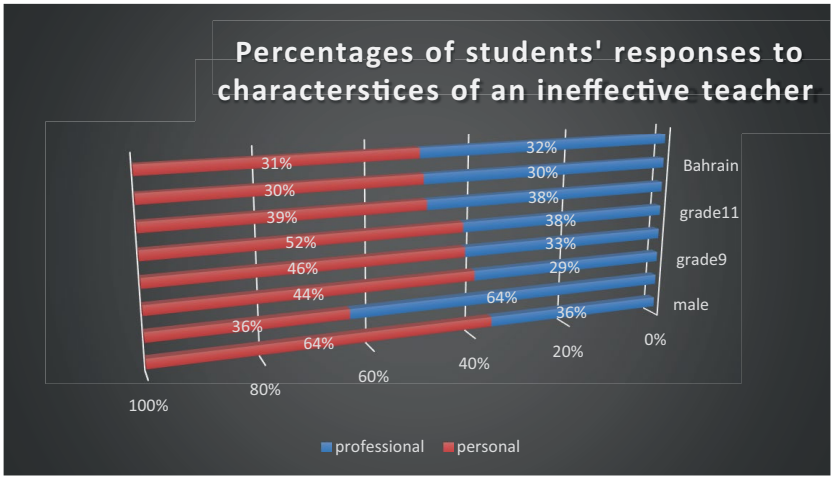

FIGURE 3
Percentages of students' responses to ineffective teacher characteristics.

TABLE 6 Shows the professional and subsidiary characteristics.

	Characteristic	Sub-characteristics
What professional characteristics do you believe make a teacher ineffective?	Knowledgeable 30%	Grasp of classroom
		Can meet the demands of students.
		Understanding of classroom management and organization.
	Facilities learning 25%	Can increase student comprehension
		Can assist learning rather than direct it.
		Puts us in the most challenging situation
	Motivates students to learn 20%	Can motivate students' enthusiasm.
		Motivate different thinking.
	Has a thorough understanding of the most subjects 15%	Creative-thinking-lessons.
		Interested in different topics.
		Gives value to unfamiliar ideas
	Generates a non-threatening setting for learning 10%	Uses tactics that promote higher-order thinking
		Ensures that learning is oriented to the needs of the students

the responses regarding professional characteristics were related to the teacher's knowledge, which included an in-depth understanding of their field and broad general knowledge, and the ability to think interdisciplinary, such as "My teacher is interested in everything." "My teacher is a bright person." "My teacher connects everything and makes it so simple to grasp." "My teacher guides me through difficult things step by step." Students' comments about their teachers' professional characteristics can be found in the sub-categories of knowledge, commitment to their subject, and intelligence. Most of the observations were on the teacher's proficiency, which included an in-depth understanding of their field and broad general knowledge, and the capacity to think interdisciplinary: "My teacher was just interested in everything." He relates everything, and he makes it so clear to understand. He teaches us the subject and then takes it a step further, making it a little easier. These remarks were frequently linked to particular remarks regarding the teacher's dedication to their job, such as "my teacher is passionate about many topics and can make me feel the same way." This shows why what they are teaching is vital.

6.3. What personal characteristics do you believe make a teacher effective?

The researcher gathered the primary characteristics highlighted by gifted students as the most personal characteristics that make their teachers effective. Following that, the researcher divided the students' responses to their teachers' personal characteristics into subgroups, as shown in Table 7.

As shown in Table 4, there are five major categories that describe how gifted students perceive their instructors' effective personal characteristics. Subcategories develop inside each category. Gifted students' descriptions of the personal characteristics of effective teachers are divided into three sub-categories: interactions with students, interactions with teachers, and interpersonal skills. Most comments centered on the skills of the teachers. The findings showed that the personal characteristics of the teacher were highly regarded by the students. Among the top-notch tasks were those requiring emotional control, perseverance, compassion, politeness, humor, and social aptitude. Students' perceptions of these characteristics of their teachers are reflected in statements like "My teacher is funny" or "My teacher is a wonderful teacher."

TABLE 7 Shows the personal and subsidiary characteristics.

	Characteristics	Sub-characteristics
What personal characteristics do you believe make a teacher ineffective?	He has a sense of humor 35%	He has a fun personality
		He has a fascinating and engaging style of discussing hard issues
		We do not feel the passing of time as he teaches us
	Behaves fairly with us 25%	Considers us to be adults
		Holds us in high regard
		Respects his students' cultural and ethnic diversity
	Offers support to students when they are having difficulty 20%	Devotes himself to his students
		When his students are having challenges, he stands by them
	Engages us in enjoyable activities 10%	Makes learning in the classroom enjoyable
		In his teaching methods, he renews and is non-stereotypical
	He is enthusiastic about teaching. 10%	Throughout the lesson, we become increasingly enthused
		With his attractive style, even the most complex chores become simple

Teacher-student relationships, with emphasis on the teacher's need to understand and care about students' needs, skills, and work; "she supports us when we face difficulties"; "he involves us in interesting activities"; "she gives energy to her students." An effective teacher must also regard his students as mature adults, delegate authority to them, commit to their respect, treat them fairly ("he behaves us fairly"), and earn their respect. "I could learn from him"; "set an example"; "a teacher who commands respect instead of awaiting it." Many students emphasized the importance of the teacher's enthusiasm for their subject: "A good teacher is someone passionate about teaching their subject and assisting others to better grasp it." Students also stressed the importance of good teachers balancing kindness and discipline without going too far in either direction. Being undesired.

7. Discussion

According to the PICS scale results (teachers' form), gifted students in Saudi Arabia, the United Arab Emirates, and Bahrain favored their teachers' personal qualities over their intellectual ones. The PICS data analysis showed that teachers at different grade levels believed their students were more likely than their older counterparts to value the personal characteristics of their teachers. These findings were supported by the gifted students' responses to the three open-ended questions that were posed to them, which revealed that they expressed a preference for the personal characteristics of their teachers. There was a significant difference because the middle school teachers' means were different from the secondary school teachers' means. A Scheffe test revealed that this was statistically significant at the 0.01 level. The difference between the means of the teachers of secondary school students and the teachers of middle school students caused a significant difference. This was statistically significant at the 0.01 level, according to a Scheffe test. It would seem essential that those in charge of teaching gifted students receive suitable training regarding preferred displayed teacher attributes among gifted students, given the revelations that come from an analysis of the data and the assumption that greater learning occurs when students are in a learning environment where their preferred teacher behavior is matched with the attributes of the teacher. It's possible that the difference between what students prefer and what teachers perceive they prefer is making the learning environment in the classroom less than ideal. Notwithstanding the high level of interest among gifted students, there appears to be a substantial preference for teachers who have a personal orientation besides their professional endeavors. The information shows the need for gifted students' teachers to be aware of this in order to achieve a balance of personal and professional traits that is more aligned with student preferences. Student preferences are used as a first step. It's important to remember that not all gifted students share this desire. Teachers of these students should be reminded that each student will be unique and that they should try to change their conduct whenever workable to meet each student's preferences in a situation. By recognizing and adapting to the student's preferred learning situations, teachers should be more successful in creating the ideal learning environment for the exceptional student. The assumption of this study is that gifted students may learn more when they are instructed by a teacher who exhibits behavior that is praised by the students.

To ascertain the characteristics such teachers must have in order to remain effective, the perspectives of gifted students towards the professional and personal characteristics of their teachers were evaluated. The findings of this study can then be applied to teaching methods training and improvement for proficient teachers. What qualifies a teacher as effective, as stated by the open-ended question? When gifted students' responses and comments to this question were analyzed, it was discovered that the majority of them focused on the teacher's personal characteristics, which they believe contribute to his effectiveness as a teacher. From the perspectives of gifted students from different grades, genders, and regions to which they belong, professional characteristics got less emphasis. This demonstrates that gifted teenagers place greater value on the personal characteristics than the professional characteristics of their teachers. This might be the case given that teens are the age group the research is focusing on, and a study found that adolescents value people who show them trust, acceptance, respect, and understanding more highly than other age groups (Hansen and Feldhusen, 1994; Mahfouz, 2015). The results of the study showed that gifted secondary students valued their teachers' personalities more than their intelligence and cognitive abilities. No matter the respondents' gender or grade, this pattern persisted throughout all three cohorts—Saudi Arabia, the UAE, and Bahrain. This result contrasted with Milgram (1979) results, which revealed that intellectual abilities were more highly appreciated by the gifted students. It also validated earlier studies (Vialle and Tischler, 2009).

When gifted students were asked what characteristics of a teacher they thought made them effective, the majority of their responses were arranged in frequency order. Students demonstrated a preference for teachers that engage them as active learners by utilizing a variety of pedagogical techniques. This finding is similar to Vialle and Tischler (2009) study, which found that students preferred teachers who used a range of teaching strategies to encourage them to be active learners. Many personal characteristics were highly regarded by the gifted students, who in this study believe they contribute to a teacher's effectiveness. Personal integrity, tolerance, tenderness, friendliness, a sense of humor, and an openness to new experiences were among these characteristics. Students also indicated that effective teachers maintain a delicate balance between friendliness and strictness. This is comparable to the findings from Vialle and Tischler (2009). The study's findings showed that females placed a higher priority on teachers' professional characteristics than did boys. This is in line with the findings of many other studies, including (Vialle and Quigley, 2002; Su, 2006; Mahfouz, 2015). Mahfouz (2015) explains that the girls' preference for professional characteristics is a result of their own personal traits, including motivation, self-control, and hard work. Boys' and girls' perceptions of effective teachers tended to place the highest value on factors related to classroom management and instructional strategies, such as those that encourage self-learning, role-play learning, unconventional or innovative teaching methods, and critical and reflective thinking.

In this study, more than 20 gifted students made statements like "My teacher is smarter than a lot of other teachers I know," which alluded to the personality trait of "very smart," a characteristic that indicates professional qualities. According to Vialle and Quigley (2002) study, students rate their teachers' intellectual prowess more highly as they become more intellectually gifted.

The study's findings indicated that boys preferred personal characteristics more than girls did. This result is comparable to Vialle and Quigley (2002). Su (2006) discovered in his research that the five most important personal characteristics of teachers for a sample of 168 Australian high school students are: competence, humor, respect, patience, and organization. These differences highlight the necessity of assessing teacher behavior and practices in the classroom for potential differences in how they may affect the learning of male and female students. A Leavitt and Geake (2009) study found a significant and favorable association between teacher personal characteristics and educational success, demonstrating that effective personal characteristics support teachers in meeting the needs of gifted students. Gifted students' responses to an open-ended question regarding the personal traits of good teachers were analyzed qualitatively, and the results provided in-depth information about how gifted students saw teachers' characteristics and proposed characteristics not mentioned in the earlier literature review (Su, 2006; Kornelia and Wilhelmina, 2009; Leavitt and Geake, 2009; Mahfouz, 2015; Burstow, 2018; Yasar, 2018).

The results revealed that the students' responses to the personal characteristics of teachers lend more support to the definition of these attributes as characteristics of effective gifted teachers. Given the positive nature of most personal characteristics and the high regard with which gifted students regard their chosen teachers, there could have been a "halo" effect contributing to the gifted students' favorable responses. To put it another way, gifted students may have attributed their characteristics to their chosen teachers because they liked them.

The study's results also revealed that students in higher grades preferred their teachers' personalities more often than their younger counterparts. The study's results indicated that gifted students in all three classes preferred their teachers' personal characteristics over those of their profession. This result is similar to that of Kornelia and Wilhelmina (2009). This result is comparable to that of Vialle and Quigley (2002) as well. An academically demanding high school in New South Wales, Australia, sent a questionnaire to students in years 7, 9, and 11, and the results revealed that the students preferred the teachers' personal characteristics over their professional ones.

Compared to their counterparts in Bahrain and the UAE, the majority of gifted students in Saudi Arabia preferred the teachers' personalities more. Nevertheless, most students in Saudi Arabia, Bahrain, and the UAE preferred the personal characteristics of their teachers over their professional ones. This may be explained by the significance of personal characteristics for students generally, as they view their teachers as role models and sources of knowledge. Many educational studies have also discussed the idea of the "hidden curriculum," in which students are influenced by their teachers' behavior and attempt to imitate it in most circumstances. Teachers of the gifted, in particular, have been trained to be capable of resolving the issues and challenges that their gifted students face. As a result, they possess many personal characteristics that aid in communication and interaction with their students, facilitating easier and more open learning and teaching processes. These results were consistent with many other studies, including those by Ayasra and Ismail (2013) and Al-Owaidat (2006), which found that gifted students' personal characteristics outranked all other factors in terms of importance. According to Vialle and Quigley (2002) study, teachers' personal and interpersonal characteristics were more beneficial to students than their intellectual or professional qualities. Additionally, the research of Vialle and Tischler (2005) revealed that all students in the countries from which the study sample was drawn (Australia, Austria, and the United States) preferred personal characteristics over intellectual characteristics in their teachers. Wilma and Vale's study examined the most crucial qualities and desirable characteristics in teachers of gifted students.

The findings of the educational backgrounds and demographic data of the teachers showed that 89% of them have majors that are unrelated to gifted education, and 73% of them have only bachelor's degrees. Furthermore, 50% of them did not attend any training courses. In his research, Aljughaiman et al. (2009) found that the majority of these courses concentrate on the improvement of general thinking and giftedness. The educational systems in Saudi Arabia, Bahrain, and the UAE fall short of international standards for preparing teachers for gifted students, despite the fact that the governments of those three countries have set aside large amounts of money for gifted education and developed a variety of approaches to enhance teachers' professional development. For instance, Aljughaiman and Maajini (2013) found that there are insufficient methods for identifying and educating teachers of gifted students in their study about evaluating the gifted program in Saudi public education schools in light of the quality requirements of enrichment programs. Alamer (2014) also pointed out the lack of a clear policy and oversight of the selection and training of instructors. In their study on gifted education in Bahrain, Al-Mahdi et al. (2021) noticed that the majority of teachers are stressed out by their demanding schedules and inadequate salaries. Additionally, a lot of them lack

experience in gifted education. In the same regard, Ismail et al. (2022) noted that although teachers of gifted students in the United Arab Emirates should possess a degree in gifted education to meet their needs, the results of this research reveal that only 9% of teachers in the sample study do. The majority of them hold degrees in humanities and general education. In the same regard, Ismail et al. (2022) noted that although teachers of gifted students in the United Arab Emirates should possess a degree in gifted education to meet their needs, the results of this research reveal that only 9% of teachers in the sample study do. The majority of them hold degrees in humanities and general education. Similar findings were reported by Aljughaiman et al. (2009) in his study, which revealed that in Saudi Arabia, half of the teachers had bachelor's degrees in scientific disciplines unrelated to gifted education. Mills (2003) pointed out that formal training and certification in gifted and talented education may not be the only factors to consider when choosing teachers for gifted students. Selecting teachers who are passionate about the subject matter as well as those with substantial experience in the academic field being taught may be equally crucial.

8. Conclusion

Because gifted students are different from other students, it is important to carefully select their teachers to give them the best educational opportunities. A lot of studies have been conducted on how to create effective teachers. It is essential to identify the characteristics that make teachers effective in order to implement extensive training before beginning a career as a teacher and to continue to enhance their professional activities while keeping in mind that the emphasis is on ongoing teacher training. When teachers know how to engage gifted students, many school issues—including absenteeism, violence, and dropout rates—are diminished.

According to this study, gifted students value their teachers' personal characteristics more than their professional ones. An examination of teachers' responses to a PICS scale that reveals their preferences for the intellectual and interpersonal traits that their students appreciate in their effective teachers lends weight to this conclusion. A crucial component of teacher training for working with gifted students is understanding how effective teachers are seen by their students. The main finding of this study is that teachers can be trained to be more successful practitioners with gifted students by focusing on the development of positive attitudes and interpersonal skills. Despite several studies on the impact of teacher preferences on learning using the general student population, there has not been much research on employing gifted students. The next step for researchers should be to discover whether or not student preferences have an impact on learning among gifted students. This problem needs to be solved if educators are to better meet the requirements of gifted students.

9. Limitation

While the students' perceptions of their teachers' characteristics are significant, they are insufficient to support conclusions about what teachers should or are capable of doing. Hence, limitations should be set while employing study results.

Author's note

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Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical approval was not required for the study involving human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants in accordance with the national legislation and the institutional requirements.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Digitalization as a way to promote the holistic approach to faculty development: a developmental evaluation

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Faculty Development, in the last decades, has undergone many transformations and many scholars are now wondering what will be the main feature that will characterize the next age, an age distinguished, in the academic world, by the changes that the just experienced pandemic brought with it. One of the main changes that this pandemic has brought with itself is the increase in digitalization within academic institutions and, consequently, the increase in the number of faculty development proposals that are conveyed through online initiatives. However, this is a consideration that can be read not only as a stand-alone element but also, if properly contextualized, it could be used as a way to promote Faculty Development programs that exploit the potential offered by digitalization in order to create initiatives which are linked in a mutually reinforcing bond. This choice is consistent with the adherence to a holistic approach to Faculty Development that promotes a systemic and multifocal logic. This paper presents a study conducted at the University of Verona in order to discover if the Faculty Development programs here implemented applying this approach were been able to promote a reciprocal mirroring between them. In order to answer this question, it was considered useful to investigate the results of a survey carried out on the "Competenze Trasversali" program, in its first edition, and thus still in an "experimental" phase. In order to collect the data has been used a simplified version of SWOT Analysis was used and the answers to the open questions were analyzed using the content analysis.

KEYWORDS

faculty development, holistic approach, higher education, faculty development programs, effectiveness' evaluation

1. Faculty development for the next ages

Mary Deane Sorcinelli (Sorcinelli et al., 2006; Sorcinelli, 2020) has presented an evolution of the concept of Faculty Development organized for "Ages" according to which (a) the 60s were "The Age of Scholar" in which the primary purpose of Faculty Development was to support faculty members in the development of their academic skills within their disciplines; (b) the 70s were "The Age of Teacher" in which academic institutions focused their attention on the development of their staff's teaching skills; (c) the 80s were "The Age of Developer" in which the role of faculty developers was officially recognized; (d) the 90s were "The Age of the Learner" in which more and more programs of Faculty Development were focused on promoting a more autonomous and active learning process (also through the spread of digital technologies supporting learning); (e) the beginning of the 21st century was "The Age of the Network" in which, even through the use of digital platforms, academic institutions all over the world started an enriching confrontation about their Faculty Development

experiences; (f) the years between 2010 and 2020 were "The Age of Evidence" in which universities addressed the problem of the effectiveness of their interventions, also in connection with the stakeholders' needs (Sorcinelli et al., 2006; Beach et al., 2016; Sorcinelli, 2020).

And what about the next Age, the one that now stands before us and has presented itself with the business card of a pandemic that has upset the entire globe's life and habits? What will it be like? Some scholars believe that it will be "the Age of Global Community" (Baker and Lutz, 2021, p.62), interpreting as a distinctive element of the new decade the possibility for universities to share their Faculty Development actions beyond the local dimension, thanks to the massive spread of digital tools.

This is already a refreshing perspective, but perhaps it is possible to take a step further, considering digitalization as something which is not only able to support an "international" comparison, but also which is also an essential element in the development of an internal process of "positive reinforcement." More precisely, academic institutions can use digital tools to promote specific FD actions, thus promoting also the "vision" of the academic development that surrounds them. This undoubtedly allows several academic institutions to be aware of what is happening in the other universities within the international panorama, thus leading to the promotion of an "external" globalization. But at the same time, this also allows the different actors involved in the same academic organization to be aware of what "is going on" within their own institution, therefore, promoting an "internal" globalization. According to this perspective, digital tools can be used not only as a way to "conduct" Faculty Development actions or promote them among other institutions, but they can also be employed to spread among the faculty members a shared culture that embodies the principles of faculty development not as simple "suggestions," but also as pillars around which to build the sense of one's professional actions. For this to happen, however, digital tools must be put at the service of a precise vision of Faculty Development, in which the core is the desire to involve all those who belong to the academic institution in a common project. Hence, in order to reach this goal, what is needed to be put in place is a holistic approach to Faculty Development.

The initial assumption, from which the holistic approach starts, is the idea (certainly not new) according to which it is not possible to "split" the development of an individual into separated areas. From the point of view of the Faculty Development, this concept was initially considered simply as an exhortation to plan the development actions that would be implemented by faculty members who were called into question starting from all their competencies, both professional and personal as well as "political" (understood as those skills necessary to actively participate in the flourishing of the academic institution to which they belong). Only later, this approach was extended to a "broader" look, grasping the potential not only of an "integrated" training that would enhance the awareness of the own "multiple" soul in the university teacher, leading him/her to invest in different competencies that compose it, but also of an emphasis placed on the systemic nature of the entire academic context (Sutherland, 2018).

Indeed, the holistic approach argues that it is not possible to affect academic culture (an indispensable element to be able to affect university practices) except through a series of linked actions, which are part of a common design, aimed at "involving" faculty members all around. The aim is to bring the university teacher to see him/herself as an element of a complex ecosystem in which he/she is part of a whole. Faculty members must therefore come to perceive themselves not as a cog in a huge mechanism over which they have no control, but as a living being within an ecosystem, in which their actions simultaneously foresee different causes and effects, and are inserted in a rhizomatic way within a network of multiple interconnections. Only in this way, it is possible for him/her to build a new universe of meanings in which he/she can find a profound meaning for each of the occurrences that see him/her called to action within the institution (Stensaker et al., 2017; Sutherland, 2018).

Starting from these suggestions, Faculty Development actions should follow a systemic and multifocal logic according to which they should not be considered as "single initiatives," organized in a "sectionalized way," but as connected initiatives according to a principle of mutual reinforcement. In this way, acting at different levels but consistently, it is possible to promote a "flexible" development, capable of rethinking itself even in unforeseen solicitations. In such a perspective, digital tools can represent an essential resource because they allow to emphasize their multi-perspective soul, both by creating opportunities for exchange and comparison and allowing a modular and integrated management of the initiatives.

Furthermore, the holistic approach, starting from the ecological thinking of Bronfenbrenner (1979), identifies three organizational levels, namely micro, meso and macro: it is evident that, from an operational point of view, most of Faculty Development's actions are oriented one toward the other of these levels. However, individual initiatives should maintain a contact that allows them to promote an organic growth of the individual teacher (micro level), of the groups of individuals belonging to the same organizational unit (meso) and of the academic organization as a whole (macro; Hannah and Lester, 2009; Roxå and Mårtensson, 2012; Simmons, 2020; Dorner and Mårtensson, 2021).

Hence, this means that it is necessary to be aware of the reciprocal influences within the FD programs even if they are focused on different organizational levels and, for this reason, these FD programs need to be "integrated" in the same "framework," thus linking them to a bigger, strategic aim. From an operational point of view, this means, for example, that the Faculty Development intervention should be organized with the aim to enhance the individual faculty members, such as a training intervention aimed at improving the design skills of the involved teachers, acting on a "micro" level. But it is also possible to think of an intervention that has as its purpose the introduction of a specific innovative teaching strategy within a course of study: in this case the objective is both the professional development of the individual teacher and the raising in the quality of the course of study, placing itself at a meso level. This does not mean, however, that there are no links between these two actions and consequently between these two levels. Indeed, these links are intrinsic to the very nature of the context in which they are inserted, which is systemic by its nature. Therefore, it becomes essential to be aware of these reciprocal influences and focus on them upstream, inserting them within a project of overall meaning.

Therefore, this Faculty Development approach provides interesting stimuli to promote an action planning that consciously fits into the complex and multifocal dimension of academic institutions, starting from the specificities of a challenging contemporary context and contemporary debate. However, these indications may appear to be poorly defined from a programmatic point of view and require a specific effort to be translated into application. Now we can see a practical application of the holistic approach and then derive indications to model it for a more "transversal use."

2. An experience at the Verona University

A concrete example of what is here described, is represented by two FD actions promoted by the University Teaching and Learning Center (TaLC) of Verona University, one dedicated to teachers ("Formarsi per Formare") and one dedicated to students ("Competenze Trasversali").

The "Formarsi per Formare" program is an initiative aimed to develop faculty members' teaching skills. It is structured into different activities: some meetings are seminars focused on specific contents (for example a teaching strategy, a lesson design model, or also a teaching innovation experience conducted by a colleague) aimed to promote, among the participants, a discussion about the topic in order to reflect on its possible implication in their own teaching. Others are workshop paths, each of them organized into three or four different meetings with a more action-oriented purpose. Their aim is usually to deepen a specific topic connected to academic teaching by providing the participants with the tools needed to connect these elements with their actions. All the meetings are online and synchronously conducted, but they are also registered and available to the staff through intranet. Furthermore, the materials that aim at communicating to faculty members the objective of the program as well as its organizational logic and potential, are disseminated through intranet. In particular, it is highlighted how the program is intended as an action aimed at promoting didactic innovation with specific reference to the dissemination of active teaching strategies. Finally, although potentially open to all University teachers, the program is specifically organized and promoted with reference to new hires.

The "Competenze Trasversali" program promotes training courses open to all Verona University's students, aimed to support their development from a personal, professional, and civic point of view. Starting from the framework "Life skills for Europe," the courses are organized into nine areas and propose skill-based courses connected to relevant issues in students' daily life (i.e., "Positive conflict management"), sometimes related to topical issues (i.e., "Intercultural communication"). The courses are held in digital mode (mainly but not exclusively in synchronous) and use an e-learning platform (Moodle) for the management of the moments of comparison or assessment activities required for the certification of the acquired skills. In this case, the information is disseminated both through the page dedicated to the project, which has a specific section within the web space of the Teaching and Learning Center, and through Moodle. All the courses are conducted online and the teachers are able to choose among the synchronous mode (carrying out the interventions through the University web conference tool, or Zoom), the asynchronous mode (through the Panopto platform, integrated, in the University of Verona, with Zoom and Moodle), or the "mixed mode" that intertwines synchronous and asynchronous activities. Even in this case, the structure of the project as well as its objective are conveyed in order to promote useful skills in the students both from a personal and professional point of view, without neglecting the dimension of civic engagement. To define the set of courses that will be proposed to the students before the start of each semester, TaLC submits to the teachers a call for proposals in which they are invited to elaborate a project aimed at the development of a specific life skill, starting from a format provided by the Center. The stimulus that is given to teachers is to devise a training experience that promotes life skills by targeting one of the areas proposed in the format, starting from a crucial, or in any case debated, topic which can involve all the students (for example the energy sources of the future for the Environmental area or Cybersecurity for the Digital area).

Teaching and Learning Center provides support for the definition of the project ideas and, downstream of the call process, analyzes each one of them suggesting, if necessary, a recalibration action to make the proposal better adhere to the project framework. Each course has a responsible teacher, who is the proponent, but he/she can make use of the collaboration of other teachers inside the University (often belonging to different disciplinary areas) as well as of external experts. For each course, TaLC also provides for the implementation of a specific Moodle space, giving support, where necessary, even in the management phase.

After the courses have been defined, TaLC organizes an overall calendar that takes into account all the activities, in order to avoid internal overlap, publishing the calendar on a dedicated page where the overall framework in which the program is inserted is further recalled as well as its general objectives. In the same online space, the administrative indications that regulate the program are also specified and, for each course, there are included a brief description and a summary information sheet that lists the teacher or the teachers involved, the main focus, the program, the calendar, the teaching methods and the assessment tools as well as a link to the specific Moodle space. The page also contains references to the TaLC team and in particular to the teaching tutor assigned to the project. Once this space has been prepared, direct communications are sent to all the students through the University app, which refers to the dedicated web page. At the same time, the request to disseminate the initiative to their students is sent to the Departments' offices of the University.

At the end of each course, the students must undergo an end-of-course assessment with the aim to verify the achievement of the objectives of expected learning, in terms of skills. The modalities to carry out this evaluation action are decided autonomously by each teacher, however, as mentioned, the TaLC offers support to the teachers in order to harmonize the evaluation phase with the project's global objectives. Finally, once the courses have been completed and the assessments collected, the administrative staff of TaLC will liaise with the Departments' Offices and with the IT Department in order to insert micro-credential in the student's career.

Although they are two separate programs, they have essential elements of continuity within them. Firstly, they are two connected axes of the "UNIVR per l'innovazione didattica—2021-2023" project (valid for the University Triennial Programming), promoting a vision of FD in which the enrichment of both teachers and students represents two sides of the same coin, each one essential to support the growth of University. In fact, on closer inspection, even if the focuses of the two programs are apparently different and located at two different organizational levels ("Formarsi per Formare" is mainly placed at a meso level by virtue of its specific focus on new hires, while the program "Competenze trasversali" is placed at a micro level because it aims at the development of the individual students involved in the project) they are closely related. "Formarsi per Formare" has, as underlined, the purpose to promote didactic innovation with particular reference to the diffusion of active learning, but we know that active learning does not only improve the students' academic skills but also their life skills, establishing a direct link with the "Competenze trasversali" project.

Secondly, "Formarsi per Formare" is both a formative moment and the starting point for a stronger relationship between the teachers of the University and the staff of the TaLC. Indeed, in many cases, the teachers

who attended "Formarsi per Formare" decided to be actively committed in promoting teaching innovation by choosing to dedicate part of their time to design and implement a course belonging to the program "Competenze Trasversali," therefore putting into action what they have learned about teaching innovation at the service of all the students of the University and taking advantage of this opportunity as a professional challenge. In a more general sense, we can say that both programs are linked to a single transversal objective, namely to promote a more student-oriented university education within the University of Verona.

Furthermore, the way in which digital tools have been used to unite the projects is not only a tool to conduct activities and certify the acquired skills (for both experiences, the certification through micro-credentials are foreseen: this certification is already activated for the "Competenze Trasversali" project, while it will be activated from 2022/2023 for "Formarsi per Formare"), but it also is a tool to communicate to the involved subjects the global dimension within which the initiatives were inserted.

Hence, these two projects, even if they have "their own life," are part of a wider framework that, thanks to their mutual positive interactions, promotes a systemic vision of FD at the University of Verona, according to which the growth of the institution is the result of the growth of individuals, within a harmonious and articulated environment.

3. To analyze in order to optimize

3.1. The data and the methodological framework

The two projects presented here are part of a design that refers to the holistic approach of Faculty Development: consequently, they should have highlighted, albeit starting from different organizational levels, reciprocal connections and links to a common framework, promoting what has been here referred to as "internal globalization." But did this really happen? In order to answer this question, it was considered useful to investigate the results of a survey carried out on the "Competenze Trasversali" program, in its first edition, and thus still in an "experimental" phase, which required specific attention in order to identify those elements on which to act for its optimization. The decision to analyze the feedback of the students who participated in the "Competenze Trasversali" program, and not the ones of the teachers who participated in the "Formarsi per Formare" program is not accidental. The idea behind this choice is that teachers, as they are faculty members and therefore more involved in the political and organizational life of the University, can be more aware of the global framework toward which the Faculty Development initiatives are deliberately placed. On the other side, both due to their role and the transitory nature of their experience within the academic institution, students can grasp the logic that underlies the various initiatives with greater difficulty. This is why, for the purpose of this paper, it is particularly interesting to investigate their point of view.

Indeed, the program started in the academic year 2020/2021 (the same year in which the "Formarsi per Formare" path was inaugurated in a structural way), and was composed of 32 courses and saw the participation of 3,510 students. At the end of the first year of the project (which took place during the academic year 2020/2021), it was decided to carry out a follow-up activity in order to investigate students' experience, with the aim to identify its characteristics and use the collected insights to optimize the route. The follow-up was carried out in September 2021 by means of a survey (including both open and closed questions) conducted through the Lime Survey platform arranged for the sending of the link to some students who participated in the project in the academic year 2020/2021. More specifically, the request to participate has been sent to students who have attended a selection of courses conducted in the first semester in the 2020/2021 academic year. Being a follow-up, this choice was made so that the participants had definitively completed the experience. The request was sent to a total of 1,558 students. Of these, 778 completed the survey only in the part concerning closed questions, while 244 decided to complete also the part concerning open (optional) questions. Here, consistent with the purpose of this paper, the focus will be on the students who answered the open-ended questions. Although the data are not statistically representative of the population, all the reposted responses were considered. The open questions were intended to investigate the students' experience and asked them in particular to identify the specificities of the path, suggesting both strengths and areas for improvement.

Indeed, in order to collect the data an open-answer survey, organized into four main questions (preceded by some profiling questions) inspired by SWOT Analysis, was designed. SWOT Analysis is a strategic planning method, which was developed at the Stanford Research Institute in the 1960s. Its purpose is to analyze the performance of specific programs or services in order to hypothesize changes that can improve their effectiveness. In order to do this, it focuses its attention on the strengths of a specific experience (Strengths); on its weak points (Weaknesses); on its opportunities for improvement (Opportunities), and on the risks it faces (Threats; Hill and Westbrook, 1997). In the last 2 decades, this tool has become more and more popular within academic institutions thanks to its capability to evaluate an academic program and identify its possible areas of development without reducing its complexity to a minimum common denominator and without using excessively standardized products, which would inevitably fail to capture its specificity. This is possible because it connects a focused gaze with the possibility, for the ones involved in the survey, to express their opinion in a wide and open way, thus highlighting unexpected needs and allowing a strategic development perspective (Gordon et al., 2000; Panagiotou, 2003; Helmes and Nixon, 2010; Leiber et al., 2018; Safonov et al., 2021).

In this case, a simplified version of SWOT Analysis was used with two questions focused on Strengths and Weaknesses. However, weaknesses, in accordance with the transformative vision that animates the project, were defined as something more than "something lacking": indeed, the second question has been focused on the identification of the "Areas for improvement." This is because, in this way, what was under the light were not the mere "gaps," but the necessary actions to remedy them. Then, a third question asked to the students to specify what kind of courses they would consider useful to be implemented in the next edition of the program, another useful element for the optimization of the program itself. All of these choices were made within the framework offered by the concept of developmental evaluation, according to which evaluation should be a fluid process that must define its tools and procedures consistently with its essential aim, which is not simply to identify the critical areas, but to pinpoint the optimization actions needed by the program submitted to analysis (Patton, 2006, 2016).

The answers to the open questions were analyzed using the content analysis, by virtue of its flexibility and ability to guide the data analysis process toward a progressive definition and systematization

of its salient elements, allowing to synthesize the core elements without for this losing its nuances (Elo and Kyngäs, 2008; Ramirez-Montoya et al., 2017). Besides, the inductive content analysis emphasizes, as stated by the name itself, the inductive element by acting on the basis of the principles of identification and clustering of the significant elements and allowing the creation of a coding system that can have different levels of abstraction (Smith, 2000; Elo and Kyngäs, 2008). In this case, consistently with the tool used to collect the data, the analysis of the open questions has produced a coding organized in two main categories (Strengths and Areas of improvement), and within each of these areas the main features were identified through an inductive analysis (Hsiehm and Shannon, 2005; White and Marsh, 2006; Elo and Kyngäs, 2008), while the answers to the third question were analyzed through a separate process in order to identify the areas which should be implemented.

3.2. The analysis

The content analysis carried out on the feedback provided by the students made it possible to develop the coding presented below, which identifies the elements that emerged as "strengths" and as "areas for improvement." In order to give a more in-depth reading, the frequencies with which these labels emerged from the data are also reported, expressed in terms of percentages.

Category	Labels	%
Strengths	Enrichment with respect to what has been learned within one's own studies	21%
	Presentation of interesting themes and dynamics	14%
	Many opportunities of personal growth	13%
	Many opportunities of professional growth	8%
	Applicability of the skills developed in daily life	10%
	Lively ed. effective courses	10%
	Diversified and interdisciplinary courses	9%
	Richness of the educational offer	7%
	Openness of courses to all students of the University	4%
	Opportunity to explore specific topics	2%
	Courses taught by professionals and competent teachers	2%
Areas of improvement	More active learning activities	21%
	No improvement needed	17%
	More dissemination initiatives	12%
	Increase in the number and type of courses proposed	10%
	More attention to the logistical aspects (to speed up the enrolment or certification procedure, etc.)	9%
	Courses longer and more substantial	7%
	More attention to the calendar management (avoiding overlaps with other initiatives, etc.)	6%
	More support during the assessment process	5%
	More asynchronous tasks	6%
	More synchronous tasks	5%
	Integration with face-to-face tasks	2%

This analysis allowed us to identify important elements useful for the redesign of the program, understanding which aspects needed to be consolidated and which ones, instead, needed corrective actions. Nevertheless, besides this, this analysis can also lead us to understand whether the inclusion of the "Competenze Trasversali" program in a broader framework, in close relationship with the initiatives aimed at teachers ("Formarsi per Formare" program), also allows accomplishing another step. Indeed, the heuristic action here performed also allows us to understand whether from the data emerge elements which are capable to verify the effectiveness of the approach in which they fit, i.e., the holistic approach to Faculty Development, which led to the design of the "Competenze Trasversali" program with specific attention to the elements of coherence between this project and the other Faculty Development actions promoted by the Teaching and Learning Center (as the "Formarsi per Formare" program, which in a certain sense constitutes its counterpart.)

First of all, starting from the strengths, we can see that even if the elements specified by students are different ("Enrichment with respect to what has been learned within one's own studies," "Applicability of the skills developed in daily life," etc.) many of them focus attention on a same aspect, which is the multiformity of the different courses belonging to the program ("Many opportunities of personal growth," "Many opportunities of professional growth," "Diversified and interdisciplinary courses," and Richness of the educational offer"). This lead to affirm that this multiformity of the program was explicitly recognized by the students as an element capable of helping them to go beyond their own experience, sometimes even seeing "usual" issues from different points of view.

> "*[The strength of the program is] the possibility of choosing courses that do not necessarily have to do with one's own course of study, [which] allows you to get out of your" bubble "by participating in experiences that are radically different from those you can be accustomed*" (Int. 183).

> "[*A strong point is*] *the integration of different fields of knowledge, the possibility of learning about topics that cannot be easily defined in a particular area*" (Int. 78).

In these extracts, students highlight the importance to integrate the specialist knowledge they develop within their own study paths with insights and reflections deriving from other disciplinary areas. The fact that students recognize the positive value of this interaction is significant, first of all because it reveals how they are aware that such mixtures are essential for the formation of a well-rounded member of our society, who possesses robust professional training but also has the necessary knowledge and skills to be an equipped and responsible individual and citizen. Secondly, these reflections show a positive consciousness of how the interaction among different disciplinary areas leads to mutual enrichment, laying the foundations for a second interdisciplinary look that also enriches professional training.

Nevertheless, at the same time, from the students' answers the awareness also emerged of the presence of a unique "matrix" that surrounds the whole Program.

> "*The strong point [is…] the construction of the project itself which allows you to try out various types of paths linked together*" (Int. 113).

> *"The strength [is…] the transversality but also the diversity of the courses [offered by the program]"* (Int. 27).

> *"[A strong point is] the integration of different fields of knowledge"* (In. 78)

The fact that, albeit in an unfocused way, we can find in the students' answers traces of awareness of what we could call "unity in multiformity" is significant, because it makes evident how the construction of a shared framework in which the activities are inserted and the effort to communicate the presence of this framework to the students has been perceived by the recipients of the program, even if the presentation of the common logics underlying the project needs to be further emphasized. In other words, students are telling us that they can "see" the architecture underlying the program, which combines the wealth of training offers with a clear general logic that "links" these courses, so different from each other, through a common "matrix." The realization of this goal owes much to the possibilities provided by digital tools. Central is the use of a learning platform, global but capable to support a wide differentiation and offer support to extremely diversified learning activities. This is an embodiment of the use of digitalization as a way to reach "unity in diversity," concretely promoting a shared vision of learning and teaching among the faculty members.

A second important aspect concerns the enhancement of active learning experiences: students explicitly indicated the use of active teaching methodologies within the course as the strong point of the project. As pointed out, although this was not mandatory within the program, teachers were encouraged to use what they had learned in the "Formarsi per Formare" course within the courses belonging to the "Competenze trasversali" Program. In the students' answers, there are clear references to this teaching choice, which was valued by the course participants as one of the strengths of the Program ("Innovative topics and teaching strategies").

> *"[The strong point is] the didactic [modality], the possibility of actively participating and being able to share personal experiences"* (Int. 125).

> *"The interactivity between students and teacher and between students is also excellent"* (In. 196).

This shows how the students of these courses are aware of how the teachers' use of active learning methodologies has facilitated the acquisition of knowledge and skills that were outside their area of expertise. It also shows how the active and participatory dimension has been an important element to support the students' motivation in attending these courses. Obviously, not all the teachers involved in the project were equally able to implement active teaching strategies, however, the fact that this aspect is a relevant element for the students is reiterated, through a sort of "cross-check," by some labels belonging to the area dedicated to the improvement points, since some students explicitly ask to increase the interactive dimension ("More active learning activities").

> *"[A suggestion would be to] make the course more interactive"*—(Int. 254).

> *"Use examples closer to reality"*—Int. 143.

> *"More exercises"*—Int. 117.

The fact that students can "see" the role of the teaching choices aimed at promoting greater interactivity and their consequent active participation in teaching activities is certainly an element in favor of the positive link between the two programs promoted by the TaLC. At the same time, the students' request to increase this aspect in the courses that have introduced it only in a minority, represents an element that makes us understand how active learning is considered by the students themselves to be particularly effective in promoting life skills. A link of reciprocal influence is therefore clearly outlined between the "Formarsi per Formare" and the "Competenze Trasversali "programs. In fact, on the one hand, teachers are able to effectively put to good use what they have learned in the training course dedicated to them, therefore putting themselves to the test in particularly challenging courses (both for the type of users that these courses collect, given that they are open to all University students without distinction of the course of study, and for the innovativeness of the project itself, which is placed in an extracurricular dimension). On the other hand, students themselves, thanks to these experiences, become aware of the potential of a teaching approach that sees them more empowered but also more active, through their participation in their own learning process. Also, in this case the use of the digital dimension has been functional in consolidating this bond. In particular, since both programs are conducted using digital tools, this has allowed teachers to "experience" the same tools from two different perspectives (as teachers and as learners), thus promoting a more multifocal vision of them as well as a more aware and shrewder use of them.

Lastly, a final element that emerged from the analysis of the data and which appears to be linked to our initial focus, albeit in a less direct way than the previous two, concerns the dissemination of the initiative. Although not in large numbers, some excerpts, indeed, highlighted the need to give greater visibility to the initiative:

> *"[The courses] could be more widespread"* (Int. 116).

> *"[The program] should be more publicized"* (Int. 140).

However, this is not just a "practical problem," it is an essential aspect within an initiative that makes the communication through digital tools a characterizing element of its structure. If on one hand, indeed, the communication that took place was sufficient to make several students aware of the presence of a global framework to which the activities referred (as highlighted above), on the other, however, the need was felt to push even more on the dissemination of the initiative and make more "present" within the panorama of our university, not only the very existence of the initiative but above all the sense that supports it. This aspect is instead essential, especially with respect to the starting point of this paper, which is the desire to

increase the "internal globalization" of the university in relation to Faculty Development issues because digital tools can support not only moments of dissemination but also of comparison and shared reflection. If we start from this perspective, the dissemination of the initiative is not simply an element functional to its "popularity": actually, as regards this aspect we could safely conclude that the problem did not arise, because the Program "Competenze Trasversali," at its debut, involved 3,510 students out of 25,533 students enrolled in the University of Verona (almost 14% of the enrolled students). The problem here is wider: if the choice made here was to use the holistic approach to Faculty Development as a tool to support the development of linked initiatives, capable of placing themselves in a logic of "mutual reinforcement" while supporting the confrontation on these issues within the university, the fact that the students claimed greater dissemination of the initiative is both good and bad news. It is good news because it means that the action aimed at stimulating a greater "liveliness" of the internal debate has reached the students, making them aware of the need to improve the communication that the university addresses to itself and its members. It is bad news because (as was to be expected) if an important step has been taken toward the right direction, many are still those to be taken in order to reach the final goal.

In the end, the results of the analysis show that: (a) students appreciated the diversification of the training experiences, but they are also aware of the presence of a global framework surrounding them; (b) they particularly appreciated those teachers who used active learning and ask for more experiences connected to this approach; and (c) finally, they think that the program deserves an even more "strong" diffusion across the university. What does this tell us about our starting point? What was presented here was the choice to organize the Faculty Development activities using the holistic approach as a keystone that aims at promoting a systemic and multifocal logic. The digitalization of these programs has made it possible to emphasize this link because it has embodied a way to reach "unity in diversity" which is essential for the fulfillment of this goal. Hence, the systemic vision that is at the basis of these programs and their realization through digital tools emerged from this analysis as elements fruitful connected one to another. Their connection led to the implementation of Faculty Development actions in which the presence of a global framework clearly appears, putting in evidence the presence of the reciprocal influences among the different Faculty Development programs and, at the same time, it also increased the awareness about the importance of promoting a confrontation among academic institutions, emphasizing that the internal globalization is a goal that deserves to be reached.

4. Conclusion

In conclusion, what emerges here is the idea that the FD should understand its mission as the embodiment of multifaceted, prismatic actions, which, despite their being composed of different "sides," are, nonetheless, capable of establishing among them important points of contact and mutual influence. From an operational point of view, the different Faculty Development actions should be designed "upstream" posing specific attention to these "points of contact" which represent the cornerstones from which the design starts. Only in this way, the different programs can be connected providing mutual reinforcement and linking the objectives of the different actions together so that one is not only coherent but also functional to the realization of the other. If properly designed, even programs that refer to different organizational levels can be integrated into a setting where the individual objectives are linked to a broader and more transversal global framework, aimed at an articulated but harmonious growth of the institution. This choice obviously presents complexities from an organizational point of view, as it requires a complex effort, and can be made possible only by a fully structured Faculty Development Center supported by the university governance. However, if the need from which we are starting will bring a real and lasting change in the institution, the effort to maximize the effectiveness of the interventions is worth to be taken.[1] The role that digital tools can play in this horizon is on a double level: on one hand, nowadays they are a management instrument that is an integral part of the learning and teaching actions of Higher Education and, if used in a conscious way, they can multiply the possibilities to personalize the teaching activity, promoting that flexibility and multifocality able to reach "unity in diversity." On the other hand, they can be used as a method of "dissemination" of the Faculty Development programs of the University with the aim to support the "internal globalization" to which reference has been made. To achieve this purpose, it is necessary that they are used in a coherent and integrated way and at the same time that they specifically convey the existence of those "points of contact" to which reference has been made, that is, the link among the different Faculty Development programs, by putting in the spotlight the existence of the "positive reinforcements" that bind them. In this way, digital tools would become "sounding boards" for the holistic approach that inspires Faculty Development actions and could support a process of change capable of recognizing and embracing the systemic dimension of the academic institution.

Data availability statement

The data analyzed in this study are subject to the following licenses/restrictions: the data used for this article are owned by the Teaching and Learning Center of the University of Verona and were collected in order to evaluate the effectiveness of the Faculty Development programs promoted by the Center. Requests to access these datasets should be directed to roberta.silva@univr.it.

Ethics statement

Ethical approval was not required for the study involving human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study

1 In this regard, it is worth noting that, consistently with the developmental approach (Patton, 2006, 2016), the conducted analysis was also used as a starting point to optimize Faculty Development initiatives. This led, for example, in the academic years 2021/2022 and 2022/2023 to the introduction of training courses and workshops included in the "Formarsi per Formare" program dedicated to active learning.

was not required from the participants in accordance with the national legislation and the institutional requirements.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Students' acceptance on computer-adaptive testing for achievement assessment in Japanese elementary and secondary school

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The present research aimed to investigate whether Japanese elementary and secondary schools can accept computer-adaptive tests, which is an important issue under consideration for its future introduction to achievement assessments. We conducted two studies that asked elementary and secondary school students to take a computer-adaptive test and complete the questionnaires. We assessed individual differences in achievement goals and tested whether they predicted achievement scores on a computer-adaptive test. Moreover, we asked the students about their attitudes toward different forms of tests. The study results were twofold. First, those with high performance-avoidance goals did not perform worse than those with low performance-avoidance goals after controlling for individual differences in the approach to learnings, the mediating variable. This implies that the computer-adaptive test does not reinforce students' anxiety about test taking. Second, students did not exhibit a more negative attitude toward the computer-adaptive test than the traditional fixed-item test but had a negative perception of human-adaptive tests (tests tailored by the teacher). Our results provide practical implications that a computer-adaptive test could be carefully introduced into the achievement assessment for Japanese elementary and secondary school children while considering their acceptance of the test.

KEYWORDS

computer-adaptive test, acceptance, elementary school, secondary school, achievement goal, perceived value of test

1. Introduction

A computer-adaptive test is an advanced testing algorithm based on psychometric theory and information technology. When students work on a computer-adaptive test, their ability level is estimated by their responses, and the most informative problems are subsequently presented to estimate their abilities with enhanced accuracy. Thus, students work on different problems, resulting in different time requirements. Computer-adaptive tests are widely used worldwide and have been introduced in the Test of English as Foreign Language (TOEIC), Program for International Student Assessment (PISA), and other academic achievement surveys in countries such as the US (Colwell, 2013) and Australia (Martin and Lazendic, 2018). The Ministry of Education, Culture, Sports, Science, and Technology in Japan is discussing a plan to introduce

computer-adaptive tests into the achievement assessment for elementary and secondary school students. However, the culture of having all students attempt to solve the same problems simultaneously is deeply rooted in academic context in Japan, such as university entrance examinations (Arai and Mayekawa, 2005). Therefore, it is possible that individually tailored problems that are determined by computers may negatively impact students' acceptance of computer-adaptive tests. We aimed to investigate whether Japanese elementary and secondary school students could accept computer-adaptive testing.

Students' acceptance is a pertinent issue. It determines the measurement fairness of computer-adaptive testing. A computer-adaptive test is assumed to be a theoretically efficient testing technique as it personalizes problems to make a set of the most informative test problems for accurately estimating individual ability. However, if a computer-adaptive test is unacceptable and difficult for a particular student to work on, their abilities will not be fairly assessed using this testing technique.

Students will have a different experience when taking a computer-adaptive test as compared to a traditional test. The differences between these two test formats are summarized in Table 1. When taking a traditional test, all students work on the same problems, which include a wide range of difficulties. As the problems are predetermined, students can work on them in any order. In contrast, when taking a computer-adaptive test, each student works on a personalized problem set, as the problems are selected by an algorithm based on each student's answer history. A computer-adaptive test does not provide too easy or too difficult problems for each student, which are inefficient for estimating student ability. As the problems are not predetermined, students must work on them in the order that they are presented.

Previous research on student acceptance of computer-adaptive testing has yielded mixed results. Theoretically, researchers have indicated that all students should be highly motivated to work on a computer-adaptive test as it can continue to present them with the most challenging problems (Weiss and Betz, 1973). Since the most challenging problems are neither too hard nor too easy, it is believed that students with high ability will not be bored by easy problems, and those with low ability will not be frustrated by difficult problems. Martin and Lazendic (2018) conducted a large-scale classroom experiment on elementary and secondary school students to compare their psychological responses to traditional and computer-adaptive testing. They reported that ninth-grade students who worked on a computer-adaptive tests experienced more positive motivations (e.g., self-efficacy and mastery orientation) and less negative motivations (e.g., anxiety and disengagement) than those who worked on a fixed-item test. Fritts and Marszalek (2010) conducted a classroom experiment with middle school students to compare their anxiety between the two test forms. They also reported that secondary school students who took a computer-adaptive test felt less situational anxiety than those who took a traditional paper-and-pencil test (i.e., a fixed-item test).

However, other studies have reported results suggesting that students find it difficult to accept computer-adaptive testing. Some studies report that highly anxious students are more likely to perform poorly on computer-adaptive tests (Ortner and Caspers, 2011; Lu et al., 2016). These results may be due to the familiarity with the traditional fixed-item test. When working on a fixed-item test, students can infer their abilities based on the number of problems they have solved. However, when working on a computer-adaptive test, students cannot infer their ability as they are constantly facing challenging problems, and the rate of correct answers is stable at approximately 50%. In a laboratory experiment on university students' psychological responses to the two test forms, Tonidandel and Quinones (2002) found that students with large discrepancies between actual and perceived performance on computer-adaptive tests were less likely to accept test feedback. Students may feel that they are not solving the problems as well as they thought they were capable of when working on traditional tests, which may reinforce their anxiety about computer-adaptive tests.

Students' acceptance of computer-adaptive testing procedures can also depend on their perceptions of their degree of freedom or controllability when solving test problems. Generally, as a set of problems is already determined and presented simultaneously in a fixed-item test, students can decide the order in which they will solve these. In contrast, as the set of problems is updated as the student progresses through the computer-adaptive test, they have almost no control over the problem order. In a survey on university students' preferences towards various test forms, Tonidandel and Quinones (2000) discovered that students preferred a test in which they could skip problems over a test wherein they could not. Similar studies show that students feel more anxious when taking a computer-adaptive test than a fixed-item test (Ortner et al., 2014) or a computer-adaptive test that allows them the freedom to choose problems (Pitkin and Vispoel, 2001).

Although computer-adaptive testing is a technique actualized using information technology, in principle, it is possible to create a human-adaptive test in which some human experts, such as teachers, can determine problems for individuals based on their estimated abilities. Thus, whether the diagnosis is made by a human or computer is an important issue in research on the acceptance of algorithm-based diagnostic technology. With a few exceptions (Logg et al., 2019), laboratory experiments and survey research have revealed that people are less likely to accept results diagnosed and predicted by a computer than those predicted by a human expert (Promberger and Baron, 2006; Eastwood et al., 2011; Yokoi et al., 2020). This negative attitude toward computers is partially due to the concern that they cannot

TABLE 1 Summary of the differences between a traditional test and a computer-adaptive test.

	Traditional test	Computer-adaptive test
Problem set	The problem set is predetermined. Therefore, all students work on the same problems.	The problem set is concurrently created based on each student's answer history. Therefore, each student works on a different problem set.
Problem difficulty	Including a wide range of difficulty from easy to hard.	Not providing too easy or too hard problems for each student.
Order of working on problems	Students are able to work on problems in any order they want.	Students must work on problems in the order as they are presented.

adequately infer human nature and ignore human uniqueness when making diagnoses or predictions (Lee, 2018; Castelo et al., 2019; Longoni et al., 2019).

Such a low acceptance of computer diagnostics is also observed in educational settings. Kaufmann and Budescu (2020) conducted a vignette-based experiment on teachers to compare their acceptance attitudes toward advice from human experts versus computer algorithms. They found that, when teachers decided which students should receive a remedial course based on students' profiles and past performance, they were more likely to adopt advice from human experts (school counselors) than from computer algorithms. Kaufmann (2021) also reported that pre-service teachers made similar decisions due to their low evaluation of the reliability, accuracy, and trustworthiness of computer algorithms. Although they targeted teachers who were in a position to provide tests and not the students who work on tests, there is a commonality in that the target of diagnoses is human nature. Whether students can accept the test format may depend on whether the test is computer- or teacher-adaptive.

The present research aimed to investigate whether Japanese elementary and secondary school students can accept computer-adaptive testing. To the best of our knowledge, no research has examined this topic in a Japanese population. As the culture of having all students solve the same problems simultaneously is deeply rooted in academic context in Japan (Arai and Mayekawa, 2005), it is possible that Japanese students hold more negative attitudes towards computer-adaptive testing,. Our research aims to provide important insights into the generalizability of past findings about students' acceptance of computer-adaptive testing. Moreover, our research sheds insight on how information technologies in educational practice in Japanese elementary and secondary schools could be utilized.

We began by investigating whether students who have testing anxiety performed more poorly on tests than those who do not. As a trait, we focused on individual differences in achievement goals. These goals are traditionally classified into mastery goals (to develop competence) and performance goals (to demonstrate competence) (Ames and Archer, 1987). Previously, researchers have revealed that students with high-performance goals are more likely to give up when confronted with difficult problems, while those with high-mastery goals persistently challenge them (Dweck, 1986). This is because students are anxious about avoiding situations in which failure exposes their personal weaknesses. If a computer-adaptive test reinforces students' anxiety, those with high-performance goals are more likely to perform poorly. Achievement goals are known to correlate with students' approach to learning (Senko et al., 2011, 2013) — conceptualized as the individual differences in students' process and intention in learning (Entwistle et al., 1979). Thus, we investigated the direct effect of achievement goals on performance score after controlling for approaches to learning as mediators.

Second, we investigated whether students preferred computer-adaptive testing over other test formats. Specifically, we focused on comparisons between computer-adaptive testing, traditional fixed item testing, and human adaptive testing. It is essential to ascertain whether taking a "personalized" or "personalized by computer" test changes students' preference for adaptive testing, as this finding can contribute to considering how teachers, as experts, should be involved in administering personalized tests using information technology.

2. Study 1

In Study 1, we provided elementary and secondary school students in Japan with an opportunity to work on a computer-adaptive test and asked them to participate in our survey. We assessed their achievement goals and investigated the relationship between these goals and ability scores after controlling for the approach to learning. Furthermore, we assessed their attitudes toward three types of tests:(1) a test with the same problems (traditional fixed-item test), (2) a test tailored by the teacher (human-adaptive test), and (3) a test tailored by the computer (computer-adaptive test). We assessed these attitudes twice: before and after they worked on a computer-adaptive test, as their attitudes may have changed after completion.

2.1. Method

2.1.1. Participants

A total of 870 students (474 fifth grade, 174 sixth grade, 163 seventh grade, and 58 unknown grade) from the Kansai region in Japan participated in this study. Students were recruited with the cooperation of school principals and district officials from June to September 2020, and their informed and voluntary consent was obtained prior to engaging in the study. A total of 415 students reported being male and 383 students reported being female.

2.1.2. Materials and procedures

The students participated in a classroom setting using a tablet PC. They were asked to log into an online system using a unique ID and password assigned to them in advance. First, an overview of the Computer Adaptive Test for Achievement Assessment of Elementary Education in Japan (CAT-ElemJP), the computer-adaptive test system originally developed by the authors, was provided by the test administrators. The CAT-ElemJP has a database of problems from the national achievement assessment (AY2019) with its psychometric properties, and is designed to ask for the most appropriate problems to estimate individual ability according to a certain algorithm. Students were told that their abilities would be estimated in real time, and that the most appropriate problems for each student would be asked to estimate their abilities, similar to a vision test. They were also informed that the number and types of problems they encountered could vary from person to person.

Next, the participants were asked to convey their attitudes toward the types of tests. The questions were: 'How do you feel when you hear that everyone in your class will be tested on the same problems?', "How do you feel when you hear that everyone in your class will be tested on the problems that the teacher tailored to each student?," and "How do you feel when you hear that everyone in your class will be tested on the problems that the computer tailored to each student?" They were asked to report their attitudes on a 3-point Likert scale, where 1 = *bad*, 2 = *neither good nor bad*, and 3 = *good*.

In the next step, they worked on CAT-ElemJP. The first three problems were tutorials familiarizing them with the operation of this application (e.g., answer submission and text/numerical value input). The next three problems were the same for all participants. However, from the fourth problem, different problems were presented to each individual according to their answer history, as assigned by the programmed algorithm. Participants were given problems in three

subjects (reading and writing in Japanese, arithmetic, and science), and their ability values for each subject were estimated according to their answer histories.

After completing the CAT-ElemJP, the participants completed two psychological scales: the scale for achievement goals and the scale for the approach to learning developed by Goto et al. (2018). They found that these scales were sufficiently reliable ($\alpha = 0.56 \sim 0.81$). Moreover, they tested the validity of these scales by running a correlation analysis between achievement goals, approach to learning, self-efficacy, and affective experiences in learning. They reported that mastery-approach goals and a deep approach to learning were positively correlated with self-efficacy and enjoyment, and negatively correlated with boring. As we initially focused on science, one of the three subjects, in Study 1, we used these scales in a format that asked about learning science.

The scale for achievement goals consisted of two subscales (mastery-approach and performance-approach goals) with three items each. The students were asked to indicate the extent to which each item was true regarding the goals set when studying science. Example items are "to learn as much as possible by studying science" (mastery-approach goal) and "to get a better grade at science exams than other classmates" (performance-approach goal). Ratings were made on 4-point Likert-type scale with anchors ranging from 1 (*not true of me*) to 4 (*extremely true of me*).

The scale for the learning approach consists of two subscales (deep and surface approaches) with two items each. The students were asked to indicate how often they engaged in each activity when studying science. Example items are "I try to read science books even though they contain material I have not learned in science class" (deep approach), and "When I read a textbook, I try to remember the topics that might come up in exams" (surface approach). Ratings were made on 4-point Likert-type scales, with anchors ranging from 1 (*never*) to 4 (*always*).

Finally, participants were asked to respond with their impressions of the three types of tests with the same questions posed to them prior to taking the CAT-ElemJP.

3. Results

3.1. Relationships between achievement goals and performance

We conducted a path analysis to examine the relationship between achievement goals, approaches to learning, and ability scores estimated by the CAT-ElemJP. In the tested model, the two subscales of achievement goals were hypothesized to have direct and indirect effects on ability scores through the two subscales of approaches to learning. The two subscales of achievement goals were hypothesized to covary, as were the two subscales of approach to learning and the three ability scores. Students' grades and gender (female = 1, male/others = 0) were entered as control covariates.

We report the estimated effects in Figure 1, but omit the non-significant paths to avoid complicating the diagrams. All the estimated coefficients are reported in the Supplementary material (Supplementary Table S1). As the tested model was a satiated model, we did not report any fit values. The ability scores were positively and negatively predicted by deep and surface approaches to learning, respectively. The mastery goal was strongly associated with the deep approach to learning but did not predict any of the ability scores directly. Similarly, the performance-approach goal was strongly associated with the surface approach to learning but did not predict any of the ability scores directly.

3.2. Comparing attitudes toward various types of tests

We conducted a 2 (before vs. after) × 3 (the same problems vs. tailored by the teacher vs. tailored by the computer) ANOVA to compare the attitudes toward the different test types before and after the students worked on the computer-adaptive test. The results revealed that the main effect of the test type was significant, F (2, 1,338) = 90.16, $p < 0.05$, $\eta^2_g = 0.04$. Multiple comparisons with Shaffer's methods showed that students preferred the test tailored by the computer ($M = 2.71$, SD = 0.52), followed by the test tailored by the teacher ($M = 2.67$, SD = 0.55) and the test with the same problems ($M = 2.44$, SD = 0.59). Neither the main effect of time, F (1, 669) = 0.06, $p = 0.80$, $\eta^2_g = 0.00$ nor the interaction effects, F (2, 1,338) = 0.64, $p = 0.52$, $\eta^2_g = 0.00$, were revealed (see Figure 2).

3.3. Summary of study 1

The results indicated that the students had acceptable attitude toward a computer-adaptive test in the same way as they did the traditional fixed-item test. The performance goal did not directly predict the students' ability scores, which implies that the computer-adaptive test did not reinforce their anxiety about test taking. Furthermore, the students had more positive attitudes toward the computer-adaptive test than the traditional fixed-item and human-adaptive tests, even though they worked on a computer-adaptive test. These results imply that the computer-adaptive test is not immediately rejected by Japanese elementary and secondary school students.

4. Study 2

Study 2 involved a more detailed investigation of what was revealed in Study 1 by refining the procedures regarding two points. First, we included the classification of performance-approach and performance-avoidance goals in our assessment of student achievement goals. Performance goals can be classified into two categories in terms of valance, approach, and avoidance, and these goals mainly cause anxiety and performance impairment (Elliot et al., 1999; Elliot and McGregor, 2001). We investigated whether the performance-avoidance goal would not be a direct negative predictor of ability scores on a computer-adaptive test.

Second, we assessed students' attitudes toward the tests, asking them to imagine a more detailed situation in which teachers planned to utilize each test type to refine the educational process. Tests are not only used to estimate students' abilities but also to enhance the way students learn and are taught based on these estimations. A computer-adaptive test, which is a technique for personalizing or tailoring tests for each student, may also be used to personalize their learning environment. By asking the students to imagine such prospects for teachers planning to utilize each test, we assessed their attitudes

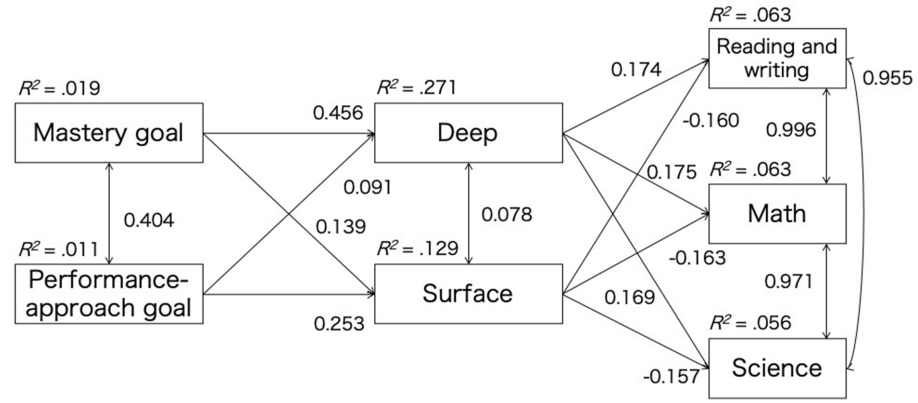

FIGURE 1
Significant path (standardized coefficients) for the path model in Study 1. Tested but non-significant paths and control variables (gender and grade) were omitted in the diagram.

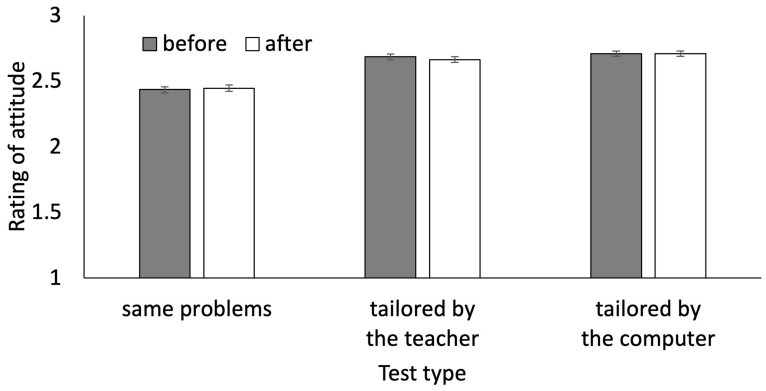

FIGURE 2
Students' attitudes toward each test before and after they worked on a computer-adaptive test in Study 1.

toward four test types: a test with the same problems (a traditional fixed-item test), a test with different problems (a fixed-item but somewhat non-traditional test), a test tailored by the teacher (a human-adaptive test), and a test tailored by the computer (a computer-adaptive test). Since their experiences in working on a computer-adaptive test did not change their attitudes for each test in Study 1, we only assessed their attitudes toward test types once they had completed the computer-adaptive test.

By focusing on the students' attitudes toward each test, we can investigate individual differences in perceived test values and their relationship with their attitudes. Suzuki (2011) has classified the perceived test values into four aspects of "improvement," "pacemaker," "enforcement," and "comparison." Students who consider "improvement" and "pacemaker" to be more valuable are more likely to be motivated by intrinsic factors and engage in a deep approach to learning, whereas those who place greater value on "enforcement" and "comparison" are the opposite. If students communicate adequately with their teachers to share the standards and purposes of the test, they can accept the test value of "improvement" and "pacemaker" (Suzuki, 2012). Thus, by examining the relationship between perceived test values and accepting attitudes toward tests, it is possible to consider how communication can change attitudes toward acceptance of computer-adaptive testing.

4.1. Method

4.1.1. Participants

A total of 745 students (540 fifth grade, 90 sixth grade, 100 seventh grade, and 15 unknown grades) from the Kansai region in Japan participated in the study. Students were recruited with the cooperation of school principals and district officials from March to July 2021. Students' informed and voluntary consent to participate was obtained prior to participating in the study. A total of 334 students reported being male and 353 students reported being female.

4.1.2. Materials and procedures

In Study 2, participants first worked on the CAT-ElemJP. Next, they completed two psychological scales: the scale for achievement goals and the scale for approach to learning. In Study 2, we used these scales in a subject-free format and asked about learning in general. In addition, the three types of achievement goals were assessed using

single-item measures for each of the following goals: mastery ("to learn as much as possible by studying"), performance-approach ("to do better than other classmates in science."), and performance avoidance ("to avoid feeling bad about not being able to study as well as other classmates"). Thus, we intended to reduce the participants' response efforts. We determined which items to use based on the results obtained by analyzing the datasets from Study 1 and the authors' previous studies applying item response theory. We estimated the item parameters by applying generalized partial credit model for each subscale separately (the estimated parameters were reported in the Supplementary Tables S2–S4). We attempted to pick up item with high Discrimination and ordered thresholds. Ratings were made on a 4-point Likert-type scale with anchors ranging from 1 (*not true of me*) to 4 (*extremely true of me*). The scale for the learning approach was the same as that used in Study 1.

When asking students about their acceptance attitudes toward each test, we presented a pictualized vignette in the format of a four-panel comic to support students in imagining how the teacher planned to utilize each test to refine educational practice. The first panel described a situation wherein two students took an achievement assessment test in one of the four test formats. The second and third panels described how the problems were presented for one student who answered the first set of problems correctly and the other student who answered them incorrectly. The fourth panel described how the teacher dealt differently with these two students based on their test scores. We used free illustrations provided by https://www.irasutoya.com/ in our vignettes and created eight four-panel vignettes: one with male and one with female characters (to control for response bias due to characters' gender), for the four tests: the test with the same problems (a traditional fixed-item test), the test with different problems (a fixed-item, but somewhat non-traditional test), the test tailored by the teacher (a human-adaptive test), and the test tailored by the computer (a computer-adaptive test). We present examples of male character vignettes for each condition in Figures 3–6. One of the eight vignettes was presented randomly to each participant. After the participants read the assigned vignettes, they rated their attitudes toward the test format on a four-point scale, where 1 = *bad*, 2 = *rather bad*, 3 = *rather good*, and 4 = *good*.

Finally, the children responded to the scale regarding their perceptions of the test value. The children's mindsets about test values were assessed using a single-item measure for each factor based on the scale developed by Suzuki (2012): "The purpose of the test was to check how I could understand what I learned." (Improve), "The purpose of the test is to get students to develop study habits." (Pacemaker), "Unless any tests are imposed, the students will not study at all." (Enforcement), and "The purpose of the test is to distinguish between those with high intelligence and those without." (Comparison). For each of the four items, the children were asked to indicate the extent to which they agreed using a 5-point Likert-type scale with anchors ranging from 1 (*disagree*) to 5 (*agree*).

5. Results

5.1. Relationships between achievement goals and performance

We conducted a path analysis to examine the relationship between achievement goals, approaches to learning, and ability scores estimated by the CAT-ElemJP. In the tested model, the two subscales of achievement goals were hypothesized to have both direct and indirect effects on ability scores through the two subscales of approaches to learning. Three subscales of achievement goals were hypothesized to covary, as were the two subscales of approach to learning and the three ability scores. Students' grades and gender (female = 1, male/others = 0) were entered as control covariates.

We report the estimated effects in Figure 7, and once again, we do not show non-significant paths to avoid complicating the diagrams. All estimated coefficients are reported in the Supplementary material (Supplementary Table S5). As the tested model was a satiated model, we did not report any fit values. Ability scores were positively predicted by the deep approach to learning, which is almost consistent with the results of Study 1. The mastery goal was strongly associated with the deep approach to learning, but did not predict any of the ability scores directly. Similarly, the performance-avoidance goal was associated with the surface approach to learning, but did not predict any of the ability scores directly.

5.1.1. Comparing attitudes toward various test types

We conducted a 4 (the same problems vs. different problems vs. tailored by the teacher, vs. tailored by the computer) × 2 (targets are males vs. targets are females) ANOVA to compare the attitudes toward the different test types (Figure 8). The results revealed that the main effect of the test type was significant, $F\ (3,\ 700) = 3.19$, $p < 0.05$, $\eta^2_g = 0.01$. Multiple comparisons with Shaffer's methods showed that only the difference between the attitude toward the test tailored by the computer and that tailored by the teacher was significant. Thus, students preferred the test tailored by the computer ($M = 3.14$, SD = 0.85) to that tailored by the teacher ($M = 2.84$, SD = 1.01). Neither the main effect of target gender, $F\ (1,\ 700) = 1.67$, $p = 0.20$, $\eta^2_g = 0.00$, nor the interaction effects, $F\ (3,\ 700) = 1.06$, $p = 0.36$, $\eta^2_g = 0.00$, were revealed.

5.2. Perceptions of test value and attitudes toward various test types

We conducted a multiple regression analysis to investigate the predictive relationship of the four aspects of the perceived test values on the acceptance attitude toward each test after controlling for students' gender and grade. The estimated coefficients are reported in Table 2. Results indicated that the "improvement" and "pacemaker" values significantly predicted only the acceptance attitude toward the test with the same problems. In addition, the "comparison" values significantly predicted acceptance attitude toward the test tailored by the teacher. No other relationships were revealed between perceived test values and acceptance attitudes toward each test.

5.3. Summary of Study 2

Consistent with Study 1, the results indicated that students had acceptive attitudes toward a computer-adaptive test as they did a traditional fixed-item test. The performance-avoidance goal did not directly predict students' ability scores, which supports the notion that the computer-adaptive test did not reinforce their anxiety.

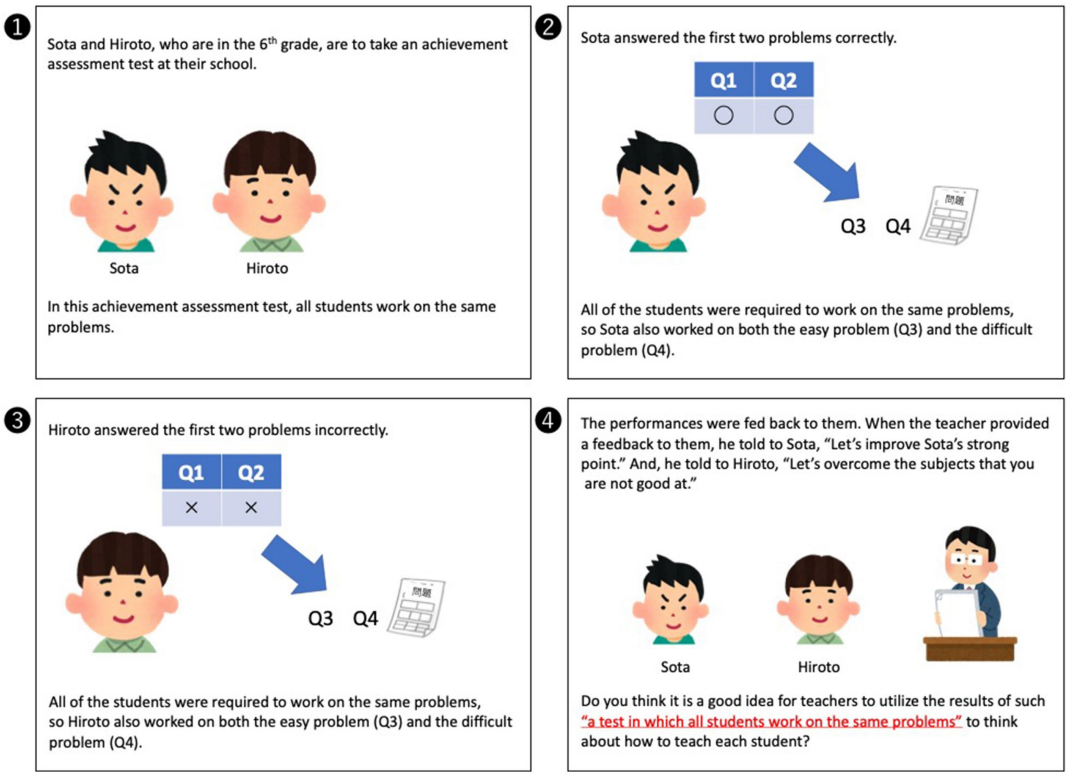

FIGURE 3
The vignette for the test with same problem conditions with male characters (translated into English).

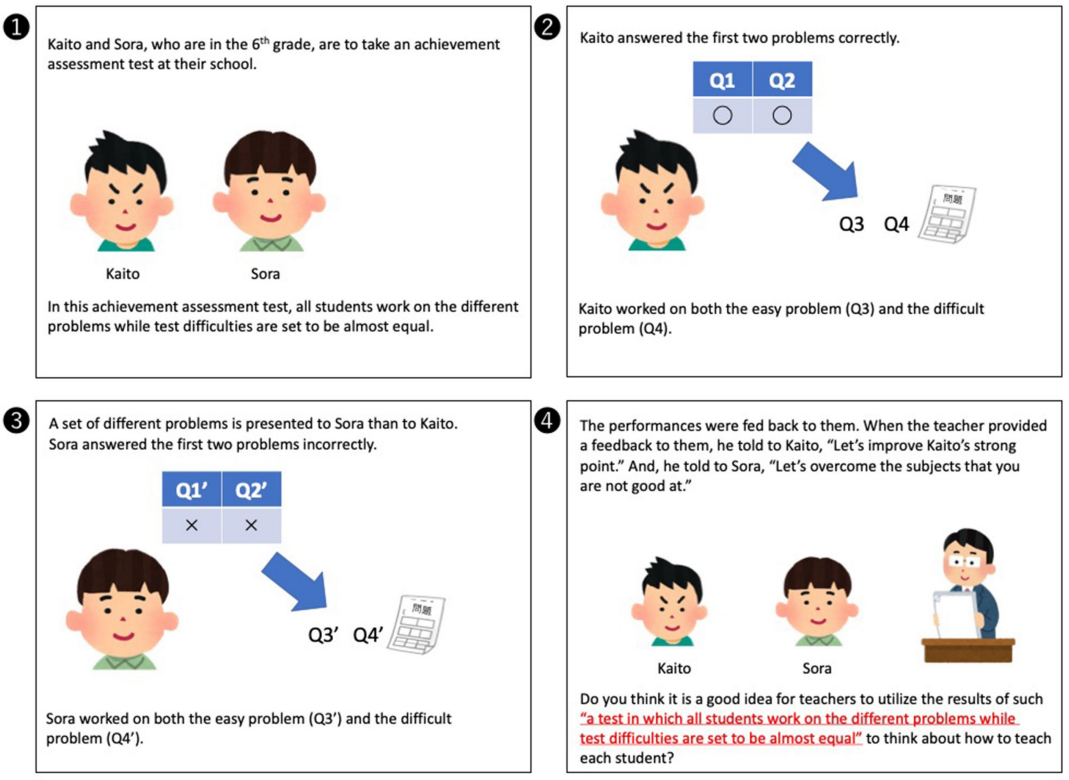

FIGURE 4
The vignette for the test with different problem conditions with male characters (translated into English).

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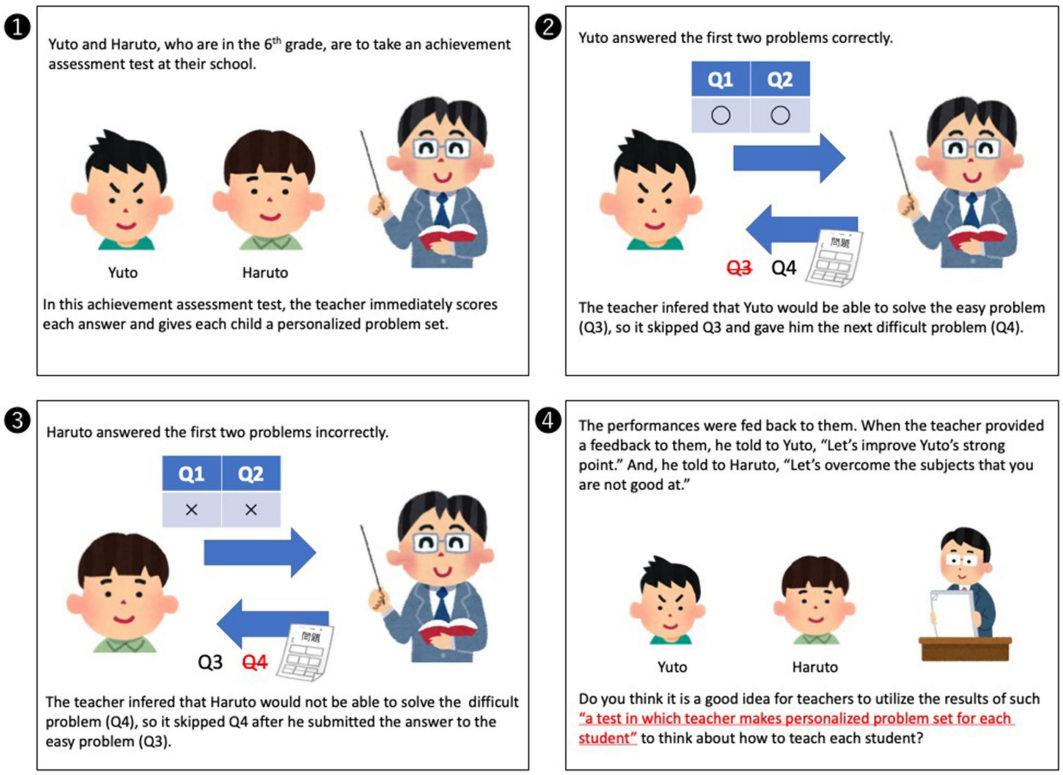

FIGURE 5
The vignette for the test tailored by the teacher condition with male characters (translated into English).

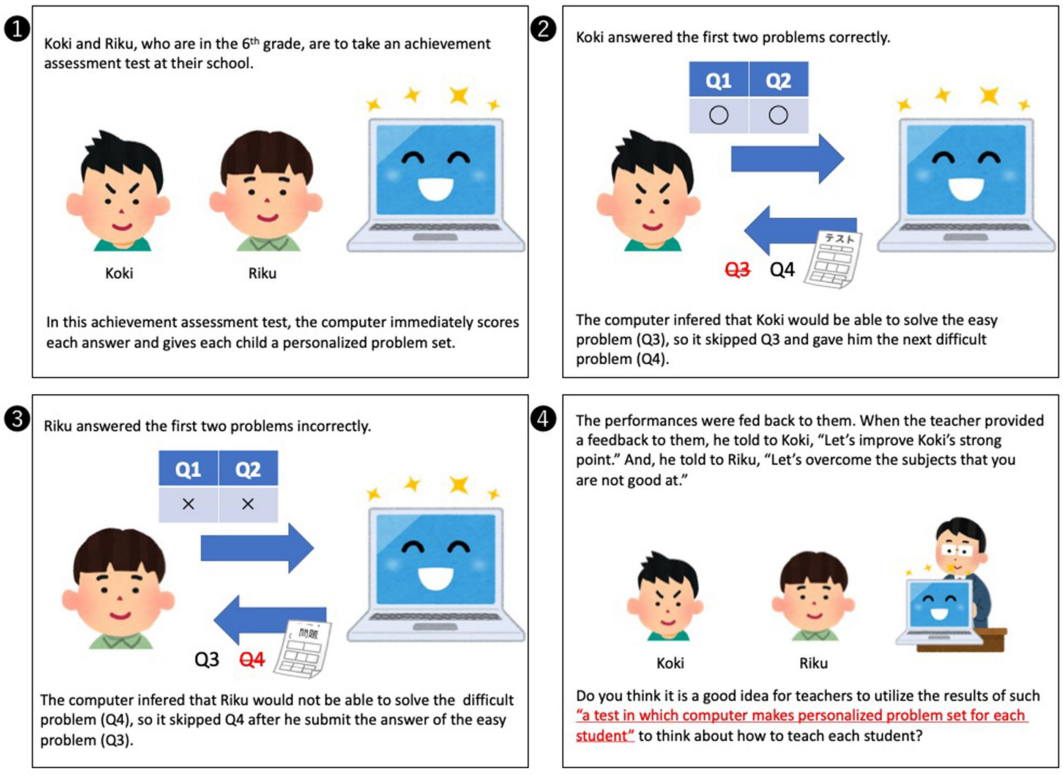

FIGURE 6
The vignette for the test tailored by the computer condition with male characters (translated into English).

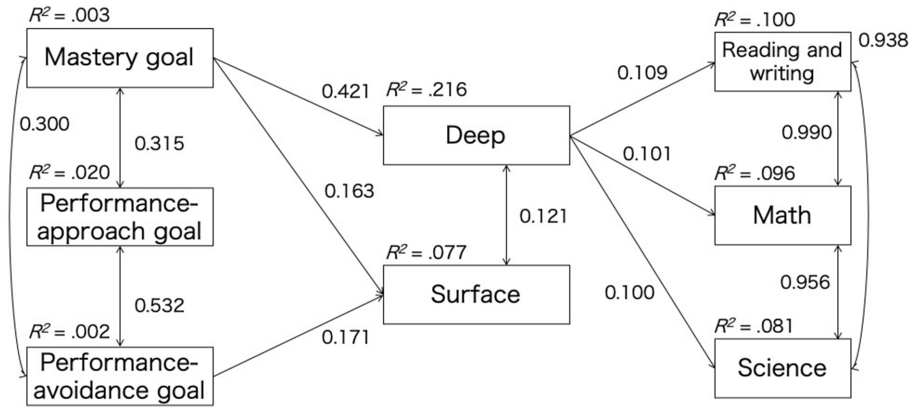

FIGURE 7
Significant path (standardized coefficients) for the path model in Study 2. Tested but non-significant paths and control variables (gender and grade) were omitted from the diagram.

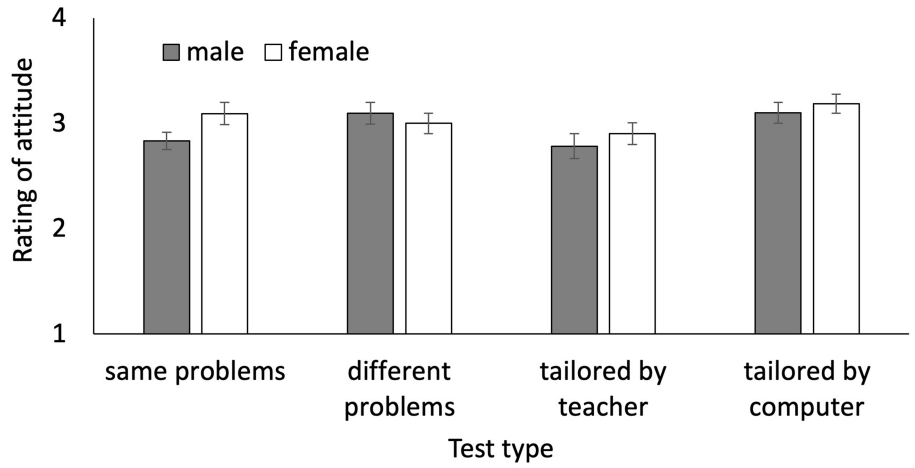

FIGURE 8
Students' attitude toward each test after reading the vignettes in Study 2.

Furthermore, even though the students considered how the teacher planned to utilize the results of each test, they did not have a more negative attitude toward the computer-adaptive test than the traditional fixed-item test. Rather, they had a negative attitude toward the human-adaptive test. These results support the notion that computer-adaptive tests are not immediately rejected by Japanese elementary and secondary school students. Adaptive aspects of the perceived test values (i.e., improvement and pacemaker) were related only to the acceptance attitude toward the traditional fixed-item test, but not to the other tests.

6. Discussion

The present study sought to investigate whether Japanese elementary and secondary school students can accept computer-adaptive testing. First, we tested whether students who exhibited anxiety toward test-taking were more likely to perform poorly than those who did not. By focusing on achievement goals as a trait, the results revealed that those with high performance goals (Study 1) or performance-avoidance goals (Study 2) did not perform more poorly after controlling for the mediating variable, individual differences in the approach to learning. These results contrast with those of Lu et al. (2016), who reported that students with high anxiety were more likely to perform poorly on a computer-adaptive test. However, there is a difference in the analytical model as their research did not control for mediators, and our research did not examine anxiety directly. Therefore, future research should address whether this discrepancy can be integrated or is due to differences in test culture or other properties in computer-adaptive testing. Regarding the context in which Japanese elementary and secondary school students work on achievement assessment, we find that the format of a computer-adaptive test does not reinforce their test anxiety.

Second, we tested whether the students preferred computer-adaptive tests to other types of tests. The results of Study 1 revealed that students did not have a more negative attitude toward the

TABLE 2 Estimated coefficients by multiple regression analysis on acceptance attitude toward each test type (Study 2).

Variables	Test type			
	Same problems	Different problems	Tailored by teacher	Tailored by computer
(intercept)	2.238	3.571	3.495	2.168
Gender	0.197	0.209	0.257	0.282*
Grade	−0.115	−0.190	−0.094	0.040
Improvement	0.212*	0.117	−0.233	0.068
Pacemaker	0.170*	0.062	0.071	0.121
Enforcement	−0.085	−0.056	−0.037	−0.071
Comparison	0.133	−0.034	0.241*	0.107
R^2	0.065*	0.020	0.050*	0.019

* $p < 0.05$.

computer-adaptive test than the traditional fixed-item test, even though they actually worked on a computer-adaptive test. While previous research has revealed that students have negative attitudes toward adaptive tests due to the lack of freedom in the order of problem solving (Tonidandel and Quinones, 2000; Pitkin and Vispoel, 2001; Ortner et al., 2014), students did not change their attitude after they worked on the computer-adaptive test in an order-fixed manner.

Consistent with Study 1, the results of Study 2 revealed that students did not hold negative attitudes towards the computer-adaptive test, even though they took into account how the teacher utilized the results of each test. Despite the dominant testing culture in Japan, where all students solve the same problems simultaneously (Arai and Mayekawa, 2005), we discovered that students do not have a negative attitude toward the test in which different problems are presented to each individual *via* a computer algorithm. These results suggest that the introduction of a computer-adaptive test for ability assessment in elementary and secondary school students is not immediately rejected due to the fairness in Japan.

When comparing computer-adaptive and human-adaptive tests, students consistently preferred the former in both studies, contrary to recent findings that people prefer diagnoses generated by a human expert over those formulated by a computer algorithm (Promberger and Baron, 2006; Eastwood et al., 2011; Kaufmann and Budescu, 2020; Yokoi et al., 2020). Even though the human-adaptive test is unrealistic, as long as teachers utilize computer diagnostics, a low-acceptance attitude toward teacher involvement in adaptive testing may break down in the classroom. Given the findings from previous research, which revealed that computer diagnoses were less acceptable due to low humanity (Lee, 2018; Castelo et al., 2019; Longoni et al., 2019) or trustworthiness (Kaufmann, 2021), trust may be the key to explaining this discrepancy in the results. Since Japanese students perceived the quality of student–teacher relationships to be low (Mikk et al., 2016), such perceived relationship quality may have impaired their acceptance attitudes toward the test tailored by the teacher. However, this is merely a speculation and needs to be empirically verified in future research, along with cultural and school climate differences.

The results of Study 2 revealed that perceived test values did not predict acceptance attitudes toward the computer-adaptive test. Among the four test types, only the traditional fixed-item test was positively predicted by adaptive values (i.e., "improvement" and "pacemaker"). While we did not find these values to predict an acceptance attitude toward a computer-adaptive test, this does not imply that we cannot encourage students to realize their adaptive value. It is possible that most students have only worked on traditional fixed-item tests, and even those who understand the adaptive value of the test well have still only accepted the traditional test. If teachers and students communicate sufficiently about the purpose and standard of the newly introduced test format (i.e., the computer-adaptive test), students may accept it. Conversely, the results also suggested that students may conservatively believe that traditional testing should continue. Given the results of Study 1, which revealed that merely taking the computer-adaptive test did not change their attitudes, we might have reached a tipping point to introducing the computer-adaptive test, where acceptance depends on whether the teacher can or cannot understand and share its value with students. It would be worthwhile for future research to examine these possibilities in an intervention study.

While our results can provide important implications for using computer-adaptive tests in Japanese elementary and secondary schools, there remains some lack of clarity due to some methodological limitations. First, as we asked students to work on our computer-adaptive test as a survey, it is not clear whether they would react in the same way if they worked on it as a high-stakes test, like an entrance exam or a diagnostic test. Second, we revealed that students have acceptable attitudes toward computer-adaptive testing but did not investigate whether this test would help students learn more efficiently. It is necessary to accumulate and systematically organize research findings with different test settings and investigate different outcomes.

This study provides valuable insights into whether students can accept a computer-adaptive test where the survey was conducted on a highly generalizable sample of elementary and secondary school students in an ecologically valid classroom setting. Our results also provide practical implications that a computer-adaptive test could be introduced into the achievement assessment in Japanese elementary and secondary schools as students have not rejected it due to the fairness. As there are other issues involved in applying computers to testing than usability and judging the correctness of answers, it is

necessary to consider what form of testing should be introduced from multiple perspectives. In addition, the time of conducting the research (2020–2021) should be considered when interpreting the results. While computer-adaptive testing is not yet widespread in Japanese schools, it is possible that in the future, as computer-adaptive testing becomes more widespread, students' acceptance attitudes could change in either a positive or negative direction. Future research should continue to examine students' acceptance attitudes toward computer-adaptive testing, considering that attitudes may shift with changes in school circumstances.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by ethical committee of Shiga University. The participants' legal guardian/next of kin provided their written informed consent to participate in this study on behalf of the participants. Participants also provided their assent for their participation in the survey form.

Author contributions

TG, KK, and TS developed the study concept and design, and collected the data in Study 1 and Study 2. TG analyzed the data and wrote the manuscript. KK and TS provided critically revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

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Impact of an inquiry-oriented proposal for promoting technology-enhanced learning in a post-pandemic context

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Introduction: This study examines the effectiveness of learning processes developed through a technology-enhanced approach in higher education. Therefore, we analyzed Webquests together with other gamification resources, considered relevant research studies on the impact and advantages of this inquiry-oriented learning approach, and examined students' perceptions of the effects of these online learning tools on developing their organizational skills and effective planning for learning.

Methods: Participants in the study were 73 student teachers enrolled in the core unit of Social Studies, in the second year of the Primary Education degree at the University of Murcia (Spain). In this study, a pre-test and posttest design was applied and questionnaires were administered to students at the beginning and end of the term to examine the impact of this inquiry-oriented approach on the development of students' learning processes. Their perceptions of the learning achieved were analyzed using statistical software for Excel (XLSTAT).

Results: The results indicate that these online tools effectively promote technology-enhanced learning and collaborative work, especially among the most motivated and digitally literate students, underlining the importance of motivation and digital literacy as catalysts for learning.

Discussion: The study also highlights the need for further research on the impact of digital resources in promoting competency-based learning alongside other motivational online approaches in tertiary education.

KEYWORDS

inquiry-based learning, online learning, learning processes, teacher education, higher education

1. Introduction

Information and communication technologies (ICTs) have widely spread in recent years, promoting the joint effectiveness and efficiency of global initiatives in several post-pandemic scenarios. Their relevance has accelerated the adoption of interrelated actions with a collective objective, maximizing the quality and speed of operational processes of people and organizations across countries, regions, and languages to develop interconnectedness and collaborative working (Younan et al., 2020).

In the field of education, ICT services have made it easier for learners and institutions to disseminate, manage and optimize information and educational processes, triggering significant research and debate on what innovative methods and approaches can best meet the needs and interests of learners and educators, especially after the pandemic period. The use and exploitation

of these tools and resources have become a guiding principle in various educational institutions focused on increasing the confidence of educators and learners in new forms of online learning. Digital education is rapidly reducing the importance of traditional instruction by transforming education worldwide, from elementary to higher education, especially during and after the pandemic (Purwanto et al., 2023).

The increasing incorporation of laptops, smartphones, tablets and other digital devices for educational purposes in education systems globally has promoted learner-centered approaches that move learners away from direct instruction and traditional teaching methods, captivated by the advantageous conditions offered by these innovative approaches: giving access to diverse sources of information, more flexible environments in contrast to traditional and more restricted time and space contexts. In this line, the adoption of Internet-based programs has provided a huge collection of content on online educational platforms and more opportunities to integrate students into new learning situations for creative and educational purposes, stimulating their ability to choose learning strategies and techniques that best suit their needs (Yuhanna et al., 2020). The digital age, in which educators and learners are deeply embedded, offers new approaches to online teaching that engage learners' attention, enhance their reasoning and improve their organizational skills, minimizing the relevance of printable material as an important source of information and learning. Moreover, these innovative learning trends emphasize collaborative work, data sharing and student cooperation to enhance best practices in various digital environments (Hamakali and Josua, 2023).

In particular, disseminating web-based resources such as Webquests clearly demonstrates how these online tools support the transition to new ways of acquiring knowledge in digital form (Adanan et al., 2020; Dousti and Amirian, 2023). These technology-based platforms were created more than 20 years ago by Bernie Dodge at San Diego State University (Dodge, 1995) and later by his colleague Tom March, who promoted them as strategic online resources for integrating web-based content into their daily teaching practice. The theoretical foundations these two education professionals developed were based on three main pillars: inquiry-based learning, scaffolded learning processes and learner-centered practices (March, 2007). Within a web-based inquiry-oriented approach, students are encouraged to experience a process of transforming newly acquired information from the browser into new learning products through reflection and creative thinking (BinTaleb, 2021; Chen, 2021). Thus, students are exposed to various selected resources to learn to see things through multiple lenses, explore a challenging situation and take effective steps toward a solution through high-level questioning (Grant et al., 2022). These challenging learning environments can encourage learners to catch up quickly, but can also make them feel overwhelmed. To alleviate this potential situation, scaffolding can help learners become more competent in completing the task. It provides structure and content to learners, as appropriate, enabling them to construct knowledge and maximize their learning outcomes. Three types can be listed according to Dodge (2022): reception, transformation and production. Reception scaffolds help learners when they are not fully prepared to retrieve information from a resource they have not worked with before. They may take the form of tips, glossaries or observation guides. Transformation may involve explicit guidance for learners to reshape the information provided into new forms of understanding. Examples of transformational scaffolding include help with comparison, analysis or decision-making. Production scaffolding includes supporting learners to create a solid knowledge base and new products. They are offered templates, creative thinking strategies and multimedia resources for creative purposes. These few examples underline the importance of adopting learner-centered approaches that focus on the learner as an active agent and pave the way for decision-making processes. Indeed, through WebQuests, learners are given ample opportunities to put their learning skills into practice and develop knowledge construction processes more autonomously (Martín and Quintana, 2011; Akhand, 2015). In short, WebQuests encourage learners to make the most of their time on the Internet by selecting and prioritizing information to personally orient their work toward more structured and strategic digital collaboration, refocusing their energy, attention and effort in a more self-sufficient way. To this end, learners can gradually acquire knowledge and improve the management of their learning process by improving their organizational skills, activating their decision-making abilities and fostering their digital competencies, which will make them feel more empowered and increase their motivation.

Initially, two different types of webquests were implemented for this purpose, involving a different time frame, namely short and long-term. The former usually last one, two or three lessons and are designed for learners to focus on acquiring knowledge and refining specific skills, while the latter give more autonomy and time for the learner, between one week and one month, to examine a body of knowledge, evaluate it and construct and build new meaning that is coherent and reflects a more sophisticated understanding of the newly constructed knowledge, as well as meaningful and relevant learning (Awada et al., 2020).

Webquests usually consist of the following organizational components (Dodge, 1995):

1. An introduction that creates a virtual context to engage learners and orient them by providing background information and identifying the task.
2. A task that describes precisely what learners should do as they progress through this web-based tool. It should be visually appealing and thought-provoking to capture learners' attention.
3. A process that specifically defines the steps learners must take to complete work on this technology-driven platform. Pre-defined resources, such as links to online information, can be provided to direct learners' energies toward building productive learning.
4. Resources comprising the set of materials intended to be used to accomplish the task. They should be easily accessible for learners to analyze, evaluate and integrate new meanings into previously substantial knowledge structures.
5. Assessment serves as a guide not only for educators to determine whether learners have done what was expected of them, but also for learners to measure their academic performance through this digital resource.
6. A conclusion that allows learners to look back on what they have learned and/or achieved as they went along in their work, and to ask themselves whether it was adequate to acquire relevant learning and how they would improve it in future tasks.

As described above, students' learning progress is enhanced by this well-planned scaffolding structure that guides them in the right direction, facilitates the best use of their time on the Internet and

fosters their creativity and problem-solving skills within a learner-centered approach (Alebous, 2021; Wahyuni et al., 2021).

Recent literature has highlighted how these inquiry-oriented approaches support active learning through the application of a variety of active and challenging strategies (Sánchez and Trigueros, 2017; Murphy et al., 2020). This learning allows students with different levels of digital literacy to progress at their own pace and gain experience and autonomy in ICT integration. In this sense, Tsichouridis et al. (2020) explored the use of these online tools to promote students' attitudes toward learning scientific concepts and found that they effectively created a positive environment among students, especially when learning complex topics and concepts. This flexible environment often develops due to the greater freedom of students to choose the strategies they wish to adopt and implement. Álvarez-Herrero and Valls-Bautista (2021) examined the learning strategies used by students to achieve their outcomes and found that they chose games as the main tool to enhance their project-based learning, which made them feel more relaxed and motivated.

The fact that learners can work more actively and freely than in traditional learning methods makes them more willing to participate in daily lessons. According to Corujo Vélez et al. (2020), who conducted research in which participants had to create their WebQuests by taking an active role in a collaborative framework, students were involved in online tasks and activities, communicating quite frequently with each other, brainstorming, analyzing and co-evaluating their online resources. Within this constructivist approach, WebQuests help students to organize the space, manage their time and plan effectively their learning tasks (McMahon, 2011; Capella, 2013). In this sense, Moundridou et al. (2020) conducted a study to explore the benefits of online platforms for fostering constructivist learning among student teachers and found that they contributed to improving students' knowledge and skills in learning design.

Moreover, as Charania et al. (2021) state, the constructivist use of these digital tools can lead to the activation of higher-order thinking skills that facilitate the development of students' capabilities in new learning contexts. Krathwohl (2002) revised Bloom's taxonomy and identified six broad cognitive categories, namely knowledge, comprehension, application, analysis, sinthesis and evaluation, being the last three of them those which revolve around higher order thinking and the use of WebQuests. Within this approach, Ozeldi and Yakin (2021) delved into the effectiveness of these online resources in developing organizational skills and highlighted the development of analysis, connection and evaluation skills among trainee mathematics teachers under a web-based approach. Indeed, Wang (2021) included programming tasks in a WebQuest design to develop students' problem-solving skills and found it a very effective way of scaffolding their learning experiences. In a similar vein, Aydin (2016) analyzed the impact of WebQuests as useful tools used in second language acquisition and foreign language learning and found that using these online tools improved interaction, communication and benefits in developing higher order thinking skills and scaffolded learning. Other studies also focus on the usefulness of WebQuests in facilitating discussion, reflection and evaluation; for example, Ebadi and Rahimi (2018) explored the effectiveness of a technology-enhanced learning environment based on the use of WebQuest on students' critical thinking and academic writing skills, and concluded that it accelerated learning progress, as students took fewer lessons to cover the required content due to the development of complex reasoning and reflection.

However, recent research highlights the challenges of using these technological tools, mainly due to the digital divide, and access to online resources, including adaptability. In this regard, Berezova et al. (2018) examined the impact of webquests on the writing and reading performance of university students and found that participants complained about the unfamiliar vocabulary they had to deal with and some inconveniences in gathering relevant information. Similarly, Amini et al. (2020) highlighted the lack of access or low internet speed as two main challenges in implementing this web-based resource. In the same vein, Srisinthon (2021), who examined the effectiveness of Webquests in a Chinese tourism course at a Thai university, put the stress on some technical problems in using them, such as a weak and irregular wi-fi connection, and concluded that a more flexible WebQuest design that could be used on laptops and mobile phones, as well as better wi-fi connection in the university, would engage students more in effective online learning.

Given the above, this study aims to examine the impact of this inquiry-oriented approach on the development of students' learning processes. To achieve this purpose, the following research objectives were listed:

> *RO1:* To analyze trainee teachers' perceptions of the effectiveness of these online platforms on their learning processes; more specifically, to analyze their views on the impact this digital approach had on their learning as a function of respondents' gender, self-perceived motivation, and digital competence.
>
> *RO2:* To measure participants' self-perceptions of the impact of some strategies that promote active learning, collaborative work and inquiry-oriented cognitive processes within this technology-enhanced approach as a function of participants' gender, self-perceived motivation and digital competence.

2. Methods

To achieve these objectives, we adopted a quasi-experimental design using pre and posttest questionnaires, designed *ad hoc* to establish the effectiveness of these online resources in a higher education context. According to Rogers and Revesz (2020), this design can effectively determine whether there is a causal relationship between a particular treatment, which may take the form of a specific program or project, and the final outcome. It is also helpful because it tends to have more practical applications, particularly in the field of social sciences. Furthermore, the administration of pre and posttest favors a directionality of the research, as following Stratton (2019), it aims to test a dependent variable (technology-driven learning) before and after the intervention with one or more independent variables (gender, self-perceived motivation, and digital competence).

2.1. Participants

The webquest program was applied in two groups of the Degree in Primary Education at the University of Murcia, Spain. The participants were enrolled in the core Social Studies unit, which is

compulsory for all second-year university students. In this research, the convenience sample consisted of 73 student teachers 17 males (23.2%) and 56 females (76.7%) who were chosen for their willingness to participate and their easy availability. The justification for the selection of this sample is based on the fact that the researchers themselves have asked their students to participate in this research as study subjects. The sample size, although not large, does not necessarily indicate a bias in this type of research (Chou and Feng, 2019). At the beginning of the term, they were informed of the entire research protocol, under the recommendations of the Research Ethics Committee of the University of Murcia. Participants were between 19 and 21 years old ($M = 19.54$ and SD = 3.17), although there was a minority of students above that age (2.73%). Less than 5% of the participants had repeated a grade. Almost half of the participants in the study were highly motivated in the field (41.1%).

2.2. Data collection tools

Quantitative data on the impact of this inquiry-oriented approach were collected using an *ad hoc* questionnaire, one of the most widespread data collection techniques, which aims to analyze and collect information in a well-structured and systematic way on the groups and variables needed to undertake the research. The advantages of this technique include the following: obtaining a large amount of data from many participants on various aspects, allowing easy and quick administration, allowing opinions to be expressed anonymously and voluntarily, and simplifying the analysis of the opinions expressed.

However, the questionnaire also has certain disadvantages, such as inaccuracy in obtaining participants' exact opinions. Compared to face-to-face interviews, not answering questions in person can lead to various interpretations, because it is impossible to elucidate the respondent's meaning. Other drawbacks are the limited response rate, the possible lack of comprehension which may lead to inaccurate answers, or the design's impersonal or overly formal style.

It consists of three sections and 27 items, the first consists of nine statements related to their self-reported motivation to use this web-based resource. The second section consists of seven statements about the learning acquired through this digital tool. The third section focuses on how this inquiry-oriented platform can promote democratic education and active citizenship. A Likert scale was used to measure participants' opinions on these questions, ranging from "1": strongly disagree to "5": strongly agree, so that respondents could openly rate each statement according to their personal way of thinking.

This questionnaire is based on a research instrument called "Evaluation of the training program based on gamification and flipped-classroom" which was already used in another study and initially validated by external experts (Gómez-Carrasco et al., 2019). It was adapted to this study from the original questionnaire and validated through a focus group discussion, in which the authors of the study above and three ICT experts provided feedback on the instrument's effectiveness, reliability and validity.

In terms of reliability, the questionnaire obtained an alpha coefficient of 0.940, which is considered highly reliable (González Alonso and Pazmiño Santacruz, 2015). Regarding the instrument's construct validity, Bartlett's sphericity test and the Kaiser-Meyer-Olkin adequacy index (KMO) were applied for each section of the questionnaire. In all three sections a critical level (Sig.) of <0.001 was obtained in Bartlett's sphericity test, and the results after applying the KMO adequacy index were 0.848, 0.828, and 0.884 in each section, respectively, supporting the validity of the data collection instrument.

2.3. Procedure and data analysis

This core unit was held in the first term of the academic year 2022/2023 (September–December). Sessions were held on Tuesdays from 4 to 6 p.m. and Fridays from 6 to 8 p.m. This core unit aimed for students to acquire knowledge and teaching skills in some relevant topics related to social sciences such as multiculturalism and interculturalism, citizenship or education in democracy. It provided a framework for systematic learning from disciplines such as anthropology, economics, geography, history, philosophy, political science, psychology, and sociology, including relevant content from the humanities. Most classroom activities included a clear articulation of these disciplines and were group-based, i.e., problem-solving activities, comparative teamwork, and case study analysis around pressing issues, which aimed to develop intellectual processes, creating multiple and frequent interactions and calls for participation through which students became more active and helped each other to make their learning more effective.

Specifically, two types of WebQuests were used in the core unit. WebQuests created by the teacher and WebQuests created by the students. The former were designed on academic content by the teaching team on a weekly basis. They aimed to increase motivation, digital literacy and promote social and civic competences. They also aimed to promote high-level thinking, and to develop problem-solving skills on the contents worked on, which resulted in the awarding of points or equivalent recognition for the work developed.

Students had to design their WebQuests in class for the same purpose. They were free to choose one of the themes around which their WebQuest should revolve, namely xenophobia, fake news, gender equity or sustainable development. They used their laptops, tablets or mobile phones to create them in groups of four or five, although they usually divided up the strategies on the digital platform to complete them. To do this, each week students were asked to search for research articles and other sources of academic information to design, analyze and evaluate content specific to social science teaching and to test their understanding and reworking of the main ideas resulting from the exchange of perspectives and the search for consensus. They were given a weekly timetable from the beginning of the core unit to self-regulate their teamwork by themselves, providing them with autonomy to manage their time, deciding the pace at which they complete their tasks and setting their own deadlines, thus encouraging self-regulation and managing the development of autonomous learning skills. They were also asked to design them following the structure of a social studies lesson plan and a specific primary school level by selecting appropriate national curriculum objectives and social studies curriculum standards to provide effective roadmaps of what should be taught in social studies classes. These elements were vital for students to develop their critical evaluation skills and to assess the quality and credibility of the content covered in class, and to filter relevant information for the digital tasks they were doing. To do so, self-evaluation and co-evaluation practices were carried out in the core unit with the aim of fostering students to lead these processes and develop their abilities to act as evaluators of their own learning and their peers.

Thus, these collaborative digital lesson plans served as an organizational basis for training students in the demands and challenges of future social studies teachers and often supported them in analyzing the questions and content previously worked on in class. The groups of students were also encouraged to develop active methodologies and collaborative work, providing opportunities for them to brainstorm and share ideas, exchange points of view, analyze and solve problems, thus improving communication and effective teamwork (Corujo Vélez et al., 2020). At the end of the term, they presented their WebQuests that were specifically tailored to curriculum guidelines and the content they had previously worked on. Discussions were held about their final products and how they had decided on a relevant topic, chosen a motivating task or integrated various technological strategies into social science lesson plans. At this point, co-evaluation was carried out so that more viewpoints were taken into account in a flexible and democratic atmosphere. Self-assessment was carried out at the beginning and at the end of the core unit, when the questionnaire was sent to the students to collect their opinion and to check whether or not the dependent variable (knowledge or attitude) had changed after the application of the inquiry-oriented approach (independent variable). Subsequently, the data were imported into a statistical program to analyze the impact of this inquiry-oriented approach on the development of the students' learning processes and to draw the relevant conclusions from this research.

Specifically, participants' responses were thoroughly analyzed using the XLSTAT statistical package. Nonparametric tests (Mann Whitney U) were applied for gender, self-reported motivation and level of ICT competence. Before that, Kolmogorov–Smirnov tests were applied to determine whether the variables were normally distributed. The mean values of the sample data are represented numerically in the following section together with information on standard deviation classified by gender and level of self-reported motivation and ICT proficiency following the pretest-posttest design.

3. Results

This section presents the findings of this study based on the information collected because of the quantitative methodology applied. The data collected and analyzed are arranged in a logical sequence with the help of tables to present the results more effectively.

Table 1 shows the means and standard deviations for each variable referring to the perception of the learning processes considered in the study according to the gender of the participants. Female students have a higher perception than male students in all learning processes studied in both tests. Within this subgroup, the perception is higher in the item "Active learning methodologies," while male students focus on the item "Educational research." Finally, it should be noted that the lowest perception in both subgroups is related to self-evaluation processes.

Nonparametric Mann–Whitney U-tests were conducted to determine whether student teachers' overall perceptions of the WebQuest-based training program differed statistically. No significant differences were found between male and female students regarding the progression of their learning processes at the end of the term.

According to the participants' level of digital competence, Table 2 shows the descriptive statistics of the perceptions of their learning processes according to the level of digital competence, with the most digitally competent students scoring higher than the least digitally competent. Specifically, the item with the highest score in the first subgroup is "Active learning methodologies," while the least digitally competent focus on the item "Educational research."

We applied Mann–Whitney U-tests for nonnormal distributions to test whether the overall perception of the participants' learning processes differs according to digital competence. This test showed statistically significant differences between the two subgroups in the overall score on the perception of their organizational skills, the development of active learning methodologies, the use of a variety of resources and self-evaluation processes, with the first subgroup scoring significantly higher than the second.

Table 3 shows the means and standard deviations of the participants' self-reported motivation for each variable referring to the perception of their learning processes used in the program during the four-month period. Among the subgroups, the more motivated respondents rated all items related to learning processes more positively than the less motivated participants. The highest scores were obtained for "Active learning methodologies" in both subgroups, with the second highest item being "Collaborative learning" in the first subgroup and "Educational research" in the second subgroup.

Mann–Whitney U-tests were conducted to test whether the shared perception of students' learning processes significantly differed according to self-reported motivation. This test revealed statistically significant differences in all items under study between the two subgroups, with "Collaborative learning" being the item with the most significant differences between respondents ($p = 0.002$).

Table 4 shows the means and standard deviations of the respondents according to gender for each variable referring to the perception of the strategies used to promote technology-enhanced learning. Overall, female students rated the strategies used during the four-month period more positively than male students, with scores above 4 out of 5 for all the items presented. Within each subgroup, and differentiating each of the strategies and techniques, the highest scores were obtained in "Small group work" by female participants, while male students scored higher on "WebQuest tasks."

Mann–Whitney *U*-tests were conducted to examine whether the student teachers' perceptions of the learning strategies used in the four-month web-based approach showed statistical differences. The results showed no statistically significant differences between the two subgroups.

Table 5 presents the descriptive statistics on the variables referring to the strategies developed in the period under study according to digital competence. In summary, the more digitally proficient students scored all items higher than the less digitally proficient students, scoring above four in the pre and posttests. Within each subgroup, both scored higher on "Small group work" and "Practical in-class activities," with the first subgroup also scoring higher on "WebQuest tasks" and the second subgroup scoring higher on "Other ICT resources."

Mann–Whitney U-tests revealed significant differences in perceptions of the use of "WebQuest tasks," "Kahoot tests," "Small group work" and "Practical in-class activities" in favor of the more digitally proficient.

Table 6 shows the means and standard deviations of the participants concerning the strategies used to promote technology-enhanced learning according to self-perceived motivation. Generally,

TABLE 1 Descriptive statistics for the variables involved in the acquisition of technology-enhanced learning analyzed by the gender of the study participants.

Issues related to learning through WebQuests	Women ($n = 55$)		Men ($n = 18$)		Mann–Whitney U	Z	p
	Pre-test AM (SD)	Posttest AM (SD)	Pre-test AM (SD)	Posttest AM (SD)			
Organizational skills	3.96	4.16	3.71	3.87	4788.5	−0.459	0.208
	(0.82)	(0.81)	(0.68)	(0.95)			
Active learning methodologies	4.14	4.31	4.01	3.93	4637.5	−0.459	0.123
	(0.76)	(0.69)	(0.61)	(0.88)			
Use of a variety of resources	4.09	4.2	3.47	3.86	4592.5	−0.574	0.084
	(0.85)	(0.75)	(0.51)	(0.83)			
Collaborative learning	4.01	4.2	3.71	4.01	4654.5	−0.567	0.304
	(0.75)	(0.73)	(0.58)	(1.06)			
Self-evaluation process	4.03	4.07	3.58	3.86	4820.6	−0.459	0.877
	(0.78)	(0.79)	(0.79)	(0.99)			
Educational research	3.98	4.25	3.41	4.02	4585.7	−0.517	0.447
	(0.82)	(0.67)	(0.71)	(0.65)			

TABLE 2 Results of nonparametric statistical tests for variables relating to the evaluation of the variables used to promote technology-enhanced learning evaluated based on level of digital competence.

Issues related to learning through WebQuests		High digital competence AM (SD)		Medium digital competence AM (SD)		Mann–Whitney U	Z	p
Organizational skills	Pre	4.28	(0.72)	3.81	(0.78)	5802.50	−0.415	0.049*
	Post	4.39	(0.78)	4.02	(0.79)			
Active learning methodologies	Pre	4.31	(0.63)	4.06	(0.74)	5709.22	−0.382	0.018*
	Post	4.52	(0.73)	4.13	(0.65)			
Use of a variety of resources	Pre	4.01	(0.67)	3.92	(0.86)	5567.25	−0.401	0.032*
	Post	4.43	(0.58)	4.02	(0.77)			
Collaborative learning	Pre	3.92	(0.82)	3.94	(0.71)	5652.70	−0.450	0.130
	Post	4.39	(0.72)	4.08	(0.78)			
Self-evaluation process	Pre	4.07	(0.73)	3.89	(0.82)	5884.21	−0.374	0.014*
	Post	4,39	(0.65)	3.91	(0.81)			
Educational research	Pre	4.23	(0.83)	3.75	(0.81)	5637.73	−0.448	0.125
	Post	4.36	(0.65)	4.15	(0.66)			

the most motivated students scored above four on the posttests, while the least motivated participants scored below four on the pre and posttests. More specifically, more motivated students scored higher on "Small group work," "Kahoot quizzes" and "Practical activities in class," while less motivated students scored higher on "Other ICT resources."

Nonparametric tests showed significant differences between the two subgroups in "WebQuest tasks," "Kahoot questionnaires," "Small group work" and "Practical in-class activities," indicating that more motivated students perceived that they had learned more with them.

4. Discussion

In the last 3 years, higher education institutions have been affected by substantial changes in the pandemic and post-pandemic period that have resulted in the imposition of social and physical constraints, in new ways of learning and the development of effective tools (Verde and Valero, 2021). Since tertiary educational administrations must simultaneously offer and demand digital competencies to learners, this study aimed to understand university students' attitudes toward the use of these online tools and gamified digital approaches.

Specifically, this study aimed to determine the student teachers' views on using WebQuest applications in conjunction with other ICT resources, e.g., Kahoot! quizzes, both by introducing them to WebQuest learning resources and by examining their impressions of the WebQuest design process. By completing the WebQuest tasks, preservice teachers have gained experience managing their learning, analyzing social issues affecting their lives, adopting diverse perspectives and checking their progress through collaborative work and critical thinking. It was observed that through active methodologies, participants effectively realized the potential of

TABLE 3 Results of nonparametric statistical tests for variables relating to the evaluation of the variables used to promote technology-enhanced learning evaluated based on level of self-perceived motivation.

Issues related to learning through WebQuests		High motivation AM (SD)		Medium motivation AM (SD)		Mann–Whitney U	*Z*	*p*
Organizational skills	Pre	4.03	(0.73)	3.87	(0.72)	6454.50	−0.406	0.006*
	Post	4.36	(0.78)	3.88	(0.85)			
Active learning methodologies	Pre	4.31	(0.66)	4.01	(0.75)	6262.85	−0.445	0.023*
	Post	4.46	(0.56)	4.08	(0.81)			
Use of a variety of resources	Pre	4.17	(0.71)	3.87	(0.75)	6132.50	−0.465	0.040*
	Post	4.34	(0.61)	4.01	(0.86)			
Collaborative learning	Pre	4.17	(0.71)	3.81	(0.72)	6218.65	−0.387	0.002*
	Post	4.43	(0.66)	3.97	(0.84)			
Self-evaluation process	Pre	4.06	(0.75)	3.87	(0.79)	6502.65	−0.386	0.003*
	Post	4.34	(0.71)	3.81	(0.85)			
Educational research	Pre	4.01	(0.91)	3.75	(0.77)	6234.22	−0.452	0.030*
	Post	4.38	(0.61)	4.05	(0.67)			

TABLE 4 Descriptive statistics for the strategies involved in the acquisition of technology-enhanced learning analyzed by the gender of the study participants.

Learning strategies	Women (*n* = 55)		Men (*n* = 18)		Mann–Whitney U	*Z*	*p*
	Pre-test AM (SD)	Posttest AM (SD)	Pre-test AM (SD)	Posttest AM (SD)			
Webquest tasks	3.81	4.07	3.41	4.06	4646.5	−0.421	0.556
	(0.78)	(0.72)	(0.71)	(1.03)			
Kahoot! quizzes	3.98	4.16	3.82	3.93	4694.8	−0.459	0.604
	(0.82)	(0.74)	(0.72)	(0.88)			
Other ICT resources (blogs)	3.98	4.18	3.88	3.85	4600.3	−0.495	0.617
	(0.78)	(0.69)	(0.69)	(1.02)			
Educational video resources	3.91	4.05	3.52	3.53	4663.8	−0.580	0.081
	(0.78)	(0.76)	(0.71)	(1.12)			
Small group work	3.93	4.27	3.58	3.92	4702.5	−0.509	0.488
	(0.75)	(0.73)	(0.71)	(0.99)			
Practical in-class activities	3.92	4.16	3.47	4.06	4615.8	−0.482	0.800
	(0.76)	(0.73)	(0.79)	(0.71)			

incorporating technologies into their learning processes. Thus, there was an increase in their autonomy in the design of online activities, which allowed them to validate the advantages and gains of these web-based tools in digital practices, including learning enhancement (Miralles Martínez et al., 2013). Nonparametric tests showed no statistically significant differences between male and female students in the overall score on the perception of their learning processes, with female students scoring higher. These results align with other studies in which female students rate the strategies adopted under active technology-based approaches to achieve more motivating learning outcomes better than male students (Gómez-Carrasco et al., 2019).

In this vein, an effective increase in motivation was observed in all participants, which indicate that many of them could continue to use and integrate WebQuests in their learning processes along with other gamified resources (Aldalur and Perez, 2023). In fact, significant differences were found between the most and least motivated learners who participated in the study, reflecting the crucial role that motivation plays in enhancing learning (Elgeddawy, 2018). In this sense, allowing students to create their own web-based resources and to reflect on their own practices can help improve their participation in daily lessons, which can contribute to their future professional development as social studies teachers and to more technology-based lesson planning in schools.

Specifically, it was found that those more competent in the use of new technologies realized more significantly the potential of organizational skills, demonstrating that being competent in digital literacy enhances learning processes and constitutes an added value of this technology-based approach (Leung and Unal, 2013). Specifically, according to Iskeceli-Tunc and Oner (2016) the use of WebQuests can positively affect

TABLE 5 Results of nonparametric statistical tests for variables relating to the evaluation of the variables used to promote technology-enhanced learning evaluated based on level of digital competence.

Learning strategies		High Digital Competence AM (SD)		Medium Digital Competence AM (SD)		Mann–Whitney *U*	*Z*	*p*
Webquest tasks	Pre	4.07	(0.82)	3.62	(0.75)	5660.20	−0.371	0.009*
	Post	4.41	(0.66)	3.95	(0.75)			
Kahoot! quizzes	Pre	4.28	(0.91)	3.85	(0.74)	5731.80	−0.394	0.038*
	Post	4.39	(0.65)	4.02	(0.75)			
Other ICT resources (blogs)	Pre	4.35	(0.63)	3.85	(0.76)	5516.20	−0.436	0.108
	Post	4.36	(0.72)	4.06	(0.71)			
Educational video resources	Pre	4.28	(0.72)	3.70	(0.75)	5605.40	−0.488	0.309
	Post	4.13	(0.83)	3.88	(0.85)			
Small group work	Pre	4.29	(0.71)	3.72	(0.72)	5765.50	−0.385	0.022*
	Post	4.52	(0.66)	4.11	(0.74)			
Practical in-class activities	Pre	4.21	(0.81)	3.71	(0.75)	5624.11	−0.390	0.022*
	Post	4.43	(0.66)	4.06	(0.64)			

TABLE 6 Results of nonparametric statistical tests for variables relating to the evaluation of the variables used to promote technology-enhanced learning evaluated based on level of self-perceived motivation.

Learning strategies		High-Motivated AM (SD)		Medium-Motivated AM (SD)		Mann–Whitney *U*	*Z*	*p*
Webquest tasks	Pre	3.86	(0.78)	3.62	(0.75)	6242.75	0.343	<0.001*
	Post	4.41	(0.62)	3.83	(0.81)			
Kahoot! quizzes	Pre	3.96	(0.86)	3.85	(0.74)	6382.50	0.367	0.001*
	Post	4.43	(0.61)	3.86	(0.79)			
Other ICT resources (blogs)	Pre	4.01	(0.74)	3.85	(0.76)	6178.47	0.471	0.052
	Post	4.32	(0.65)	3.97	(0.85)			
Educational video resources	Pre	4.06	(0.73)	3.71	(0.75)	6323.50	0.500	0.115
	Post	4.12	(0.67)	3.82	(1.01)			
Small group work	Pre	3.96	(0.85)	3.71	(0.72)	6440.75	0.427	0.015*
	Post	4.43	(0.61)	3.97	(0.89)			
Practical in-class activities	Pre	4.03	(0.76)	3.69	(0.75)	6202.96	0.338	<0.001*
	Post	4.46	(0.62)	3.86	(0.68)			

students' mastery of web search skills such as browsing, data filtering or data and information management, as found in this study as participants scored higher on the organizational skills item in the posttests.

It is also necessary to underline the relevance of active methodologies and collaborative work in improving self-reported levels of perception of technology-based learning. Students' posttest scores reflect the success of teamwork in sharing ideas, self-regulation and problem solving on these e-learning platforms. These findings coincide with those obtained by other studies such as those of Corujo Vélez et al. (2020), who highlight the relevance of collaborative skills among students when creating WebQuests, such as communicating and making themselves understood, the ability to adapt to new situations and to generate new ideas and the ability to be socially competent in teamwork and joint decision-making.

Another important and vital point for students to feel responsible for their own learning is self-evaluation. Through the creation of WebQuests, students were provided with opportunities to promote critical thinking, develop their abilities to argue on the basis of the content they have worked on, and be aware of the goals they have achieved, their successes and also their failures, as well as their capabilities (Liang and Fung, 2021). In this study, participants scored higher on this item in the posttests because they were allowed to make use of explicit reasoning and exploratory talk in the co-evaluation practices of teamwork, which clearly contributed to improving the quality of their own learning processes and their impressions of them.

5. Conclusion

In this study we have observed how Webquests can enhance the learning and practice of different skills and competences in a higher education context. The results obtained, which ensure that

the research objectives are met, pave the way for further studies on the planning and design of learning experiences in face-to-face and virtual environments, the development of online collaborative learning resources, the guidance and evaluation of knowledge construction or the management of learning achievements and progress with ICT support.

We have seen that the mastery of digital skills together with higher levels of motivation to learn and work collaboratively in the design of these technology-based resources can facilitate the development of relevant skills related to teamwork, digital literacy, organizational skills, and critical thinking (Carretero et al., 2017; Guerrero et al., 2022). This was made possible through active learning strategies and methods, such as practical classroom activities, videos, discussions, quizzes and cooperative work (Campillo-Ferrer and Miralles-Martínez, 2022). In this line, the fact that student teachers felt responsible for their own learning processes has also been very effective in self-regulating their understanding through original experiences, rather than just passively absorbing information. As autonomous learners, they have had the opportunity to manage their learning time, experience real-life-like situations, reflect on them and construct knowledge by scaffolding their pre-existing comprehension of ideas and concepts (Romero-García et al., 2020). In this sense, the information gathered in the research can help us consider the weight of these learning experiences in rethinking the importance of these learning experiences in the development of teacher education, and the relevance of web-based content in current higher education curricula (Prendes et al., 2018).

This way of students working collaboratively, from constructive thinking, exchanging different perspectives and supporting each other responsibly under the principles of constructivism and dialogical learning, clears the way for more innovative online proposals that more accurately reflect the preferences and interests of students in higher education contexts (Synekop, 2020). In this sense, it seems crucial to develop new forms of teacher education, where students can play an important role in learning community projects within a democratic and reflective approach, where they can engage in cooperative work, with a balanced combination of social sciences, pedagogy and technology-based practices (Corujo Vélez et al., 2020).

In this sense, for future implementations, it is essential to consider some issues to appropriately improve students' learning skills in teacher training (Rodrigues, 2020). It is necessary to allocate more time and digital tools for students to develop their learning competencies and incorporate digital technology into their learning processes, by collecting, examining and interpreting secondary and primary information, and solving relevant current social problems. More specifically, it is essential to design unit plans that integrate motivating digital content that challenges their learning ability to give preservice teachers more opportunities to maximize web-based learning experiences in higher education contexts (Piedmont, 2020). In this sense, it would also be desirable for the core unit of Social Studies to design new lesson plans that combine both techniques more effectively (gamification and web-based learning instructional model) and deal with different theoretical aspects of the subject. These lesson plans could include gamified questions as ice-breaker activities that would allow us to know to what extent the students know the subject before tackling the practical part of the subject.

6. Research limitations

Several limitations have been examined in the present research. The first limitation is that the study was carried out in two groups of students enrolled in the core Social Studies in a city in Spain, which reflects a very specific context, which does not allow for generalizations outside the context under study. The sample size is not large and may affect external validity, reducing the power of the study and increasing the margin of error. It is advisable to enlarge the sample size of participants to obtain more accurate values and lower standards of the deviation of the considered items. The second limitation is related to the activities, tasks and quizzes designed for each WebQuest. The design and choice of different tasks could bring about a change in the participants' perspectives in each of the variables analyzed. Furthermore, the results of this study relate to the preservice teachers' opinions on the use of WebQuests, which should not be equated with their real academic performance during the period under consideration, which stands for another limitation of this study. As suggestions for future research, it is recommended to analyze students' actual academic performance to see whether students' perspectives correlate with their academic results. Another suggestion is to improve lesson plans by adjusting their design to students' needs, interests and preferences and then to examine their actual learning after these adjustments have been made. In this sense, applying mixed methods research with quantitative and qualitative data would allow for an in-depth understanding of student teachers' views on the impact of these web-based resources on teacher education. Similarly, research extending beyond one term could detect possible changes in participants' perceptions at individual and group level, thus adding value and quality to the research.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

J-MC-F and PM-M contributed to conception and design of the study and wrote sections of the manuscript. J-MC-F organized the database and performed the statistical analysis. PM-M wrote the first draft of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2023.1204539/full#supplementary-material

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Fostering future music teachers' professional skills: developing a signature pedagogy using e-learning

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Introduction: The emergency crisis due to the COVID-19 pandemic caused noticeable changes that stimulated the transition to the new normal based on the digitalization of our systems. In this regard, the revision of learning tools in higher education exposes new challenges and requires the development and implementation of digital technologies. Fostering future music teachers' professional skills needs designing of online resources that provide close student–teacher interaction, as well as the engagement of students and regulation of their professional music practice. Based on the theory of Shulman, the signature pedagogy in music education was developed and implemented in an e-learning environment by a small private online course. The aim of the research was stated: How and which students' music teacher professional skills are affected in the process of e-learning based on the signature approach? The research was conducted at Kazan Federal University. During the educational process students studied the professional practicum.

Methods: Totally, 124 students from 1st to 4th academic level had taken part in the experimental work in the academic year 2021–2022. All of them studied bachelor programs for future music teacher as full- or part-time regime and studied the online course in MOODLE during the experiment. A combination of online tasks which cover all the types of the music teacher' professional activities was suggested. Considering the aim of the research, the multi-case study research methodology was chosen, using a mixed method approach, resourcing mainly to questionnaire, interview, documental analysis, and observation as data gathering methods, and descriptive statistical analysis, as data analysis techniques.

Results: The main results demonstrate the effectiveness of the developed online course that allowed to significantly foster students' music teacher professional skills.

Discussion: The investigation of the efficiency of using e-learning for training future music teachers' professional skills was carried out in this study. To improve future music teachers' skills according to the features of the professional field, a signature pedagogy approach was suggested. The contribution of the paper brings the detail characteristic of the signature pedagogy in music education, and the way of its implementation by the means of online tools.

KEYWORDS

music education, online teaching and learning, digital technologies, tools, pedagogy, higher education

Introduction

The current trends in education are determined by global wave of digitalization, and the availability of e-educational resources and multifunctional devices has stimulated teachers all over the world to upgrade to digital pedagogical technologies (Kampa, 2021). The COVID-19 pandemic situation highlighted the digital transformation of teaching as an extremely relevant transition to cater to the needs of crisis-like situations witnessed during lockdown due to COVID-19, or other emergencies that may need to face in future (Gibson, 2021). Recent research has emphasized that the future requires teachers to be competent for providing education in a remote way even more effectively than in traditional face-to-face settings, while we recognize online interaction with students as our new normal (Wu, 2021). Although digital upgrading has had an impact on most of the dimensions of the education system, not all subjects and fields could transform immediately, including traditional ones like music education that are undergoing gradual transitions and appropriate ways to adopt pedagogies that are still being explored (Phipps, 2021).

While online learning of the history and theory of music has been available via massive online courses for a long time, remote teaching of musical performance skills is a relatively new trend in music education (Pike, 2017; Karkina et al., 2022). The implementation of learning in music classes that involve performance by using digital resources puts forth challenges in the organization of the close student–teacher interaction as well as the interaction between the participants of vocal or instrumental ensembles. Besides, active engagement of students in the learning process requires systematic organization of their self-preparation process, including the instruments of control and assessment, all of which should be delivered online. Some issues of music learning that were faced while using digital sources were studied in the past, including collaborative music ensemble project work (Gibson, 2021), teaching piano by Skype (Pike, 2017), designing online music courses in both synchronous and asynchronous ways (Biasutti, 2018; Love and Barrett, 2019), digital sources for improving music ensemble skills through visualization (Li et al., 2019), or the personal laptop (Sheffield et al., 2019). However, the professional online training of future music teachers has not been widely researched and still needs an in-depth analysis of the possibilities and tools.

Background

Music education is an essential part of the social, psychological, and spiritual development of children, and music class is a mandatory discipline of the general school curriculum all over the world (Abdullin and Nikolaeva, 2006). Children learn music to improve their skills in the field, such as their ability to listen to music, play musical instruments, sing, describe, and analyze it throughout middle school. Music education aims at improving musical intelligence, defined as the "ability to perform, compose and appreciate music and musical patterns" (Gardner, 1973). Additionally, music lessons have an important role in the development of aesthetic awareness, the ability to distinguish beauty in art, nature, and person interactions (Karkina et al., 2020). Bearing in mind all these duties, we figure out the complexity of music teachers' professional activity and the need for special educational training as a continually growing deficit of music teachers has been noted in different countries (Mateos-Moreno, 2022).

Music teachers' professional skills

An overview of recent research in music education indicates the critical dependence of music teaching from the perspective of educational institutions as well as teachers' professional development and ability to manage the musical content and pedagogical skills (Valdebenito and Almonacid-Fierro, 2022). Based on the documentary analysis of instrumental music education, researchers highlight the meaning of professionalization and specialization as a crucial dimension in the model of the music teacher (Sanchez-Escribano et al., 2022). Recent research has also noted systematic training in musical skills and professional activity as a pivotal factor for achieving music teacher competences (Carrillo and Vilar, 2012).

Teaching music as well as other art classes and physical training during initial education needs specific preparation separate from all other disciplines. While the basic disciplines of the primary school curriculum including mathematics, literacy, languages, geography, and science are taught by the same teacher, classes in music, arts, and physical exercises are conducted by other teachers. Recent research confirms that the "preparation of classroom teacher for the implementation of music art learning has not been supported by adequate professional competence" (Ghozali, 2020). Considering the high importance of early childhood music lessons, scholars emphasize the need "to raise awareness among educational policymakers, teacher educators, and school leaders around the world about the urgent need to better prepare" initial school teachers in music education (Bautista et al., 2022). Moreover, they highlight the major role of teachers' level of specialization in music education in their professional motivation and preferences (Bautista et al., 2018).

The set of music teachers' professional skills includes the ability to sing, play musical instruments, compose and improvise music, describe it, and analyze it. Above that, modern researchers state the role of creative thinking in enhancing imagination, "developing the emotional component of music performance, and fostering improvisation skills" (Zhang et al., 2021). Scholars note the development of critical thinking skills in the musical performing class as a fruitful way to improve musical competencies (Latifah, 2022). These two components of music teachers' professional development were also pointed out in the context of designing online courses as the main vectors of the educational model (Karkina et al., 2021).

The study of the professional competences of a music teacher based on the perceptions of real specialists seems to be a very productive way for the effective development of this profession (Aguilera and Monmany, 2016). Considering personal professional practice, teachers emphasize the necessity of long

and work-intensive professional development (Bautista and Wong, 2019). In this process, they also value active learning and close interaction with colleagues (Bautista and Wong, 2019), who encourage, support, and provide critical feedback. Researchers state that the real professional experience determines the teacher competence frameworks. Based on this statement, Puffer suggested a model of general music teachers' professional competence, which includes four components: "subject-specific professional knowledge, situation-specific skills, artistic musical abilities and skills" (Puffer and Hofmann, 2022). The latest research works highlight the pivotal trends in music teacher education, such as real school experience, subject-specific professional knowledge, and situation-specific skills, that correlate key aspects to the theory of professional development of Shulman (2005). The conception of signature pedagogy, defined by the American scholar Schulman, reveals the structure and hidden curriculum of professional pedagogy and allows to determine the fundamental approach to future specialists' preparation processes.

Signature pedagogy in art education

The term signature pedagogy was coined by Shulman (2005) to denote the characteristic forms of professional teaching and learning and was defined as a fundamental approach in which future specialists are educated. The core of Shulman's theory includes three dimensions of professional practice that should be mastered by students: to think, to perform, and to act with integrity. According to Shulman, each professional activity is characterized by the priority of one of these dimensions, and the teaching methods will be more productive if they are systematized from one characteristic professional feature to another. That means one of the aspects, such as intellectual, technical, or moral, should determine the leading trend of the professional preparation, while the other two will support it.

Faculty disciplines in the liberal arts and sciences provide the training of student's generic skills, including critical thinking, academic writing, and quantitative skills, which are not unique to specific disciplines. At the same time, if any institution is trying to deliver more than basic content to students, there is a need to use the ways of thinking and habits of mind that are used by real professionals. To educate students about the intellectual moves and values of experts in the field, university programs need to include corresponding subtext as the learning outcomes of disciplines.

The signature pedagogies reflect the core values of the professions and thus evolve slowly over a period of time without visible changes. Historically, the medical rounds are associated with the signature pedagogy of medical education, while critical reading is associated with the pedagogy of literature. Consequently, the in-depth study of the professional practice and description of it is a crucial bridge to the desired goals and the way to improve student's learning results. Signature pedagogy belongs to the concepts that involve creativity and thought-provoking elaboration. Following Shulman's definition, the implementation of a signature pedagogy proceeds the tradition of the professional field in the points of practitioners' deepest beliefs and practices (Chick et al., 2009). The study of real professional practices helps in the understanding of the signature practice of students' learning.

Currently, researchers explore signature pedagogies in university curricula for all subjects, including history, geography, psychology, agriculture, biology, computer science, physics, and mathematics (Chick et al., 2009). They suggest signature pedagogies as learning methods that can help students engage in professional activity. Scholars of literary education point to social annotation practices as a signature pedagogy that proposes an aesthetic mode of reading (Clapp et al., 2021). The technologies of digital story telling used by researchers in the field of humanities were described as a signature pedagogy (Benmayor, 2008). Among the modern educational trends, the transdisciplinary approach was defined as a signature pedagogy in the field of science by means of its integration with art (Straksiene et al., 2022). Arts integration as a signature pedagogy in educator preparation was also explored by Reck and Wald (2018). Additionally, researchers have proposed a signature pedagogy for art therapy education (Leigh, 2020).

Shulman (2005) possessed a comparison of two different courses in engineering school. He argued that the common lecture practice in which students just listen to their teacher does not satisfy the core values of an engineer. In other cases, he demonstrates the classroom where a teacher is instructing the student's experiments and is collaborating; the activity of a teacher as he "circulates among the work areas, and comments, critiques, challenges, or just observes" (Shulman, 2005) is defined by Schulman as the most signature way of teaching for the engineering field. The scholar characterized the core of the field of design as training of the heart. The pivotal role of pedagogy that he determined for the method of critique had been widely studied by his followers in graphic design (Motley, 2017), as well as in the field of Arts and Humanities in general (Motley et al., 2017), in writing studies (Heinert, 2017), dance class (Kearns, 2017), and music performance (Hastings, 2017).

In regard to performing education, studies of signature pedagogy were noted for the theater arts (Kornetsky, 2018). Though performance in relation to music and the feature of signature pedagogy in this field were researched earlier (Gary et al., 2009), challenges are posed while defining the best kind of education and training for equipping "music students to navigate and increasingly dynamic and complex professional environment" (Creech et al., 2022); thus, scholars suggest creative collaboration as a signature pedagogy for advanced music training and professional development in this field. With respect to musical practice, researchers enriched the area of signature pedagogy studies by exploring the development of creativity in an orchestral composing activity (Love and Barrett, 2019).

While Shulman (2005) positioned signature pedagogies as a relatively stable concept in education, he mentioned that changes in teaching conditions can lead to substantial transformation of the signature pedagogies. He pointed out objective facts of practice that may change the professional activity so much that they may stimulate the development of the pedagogies. He described dramatic examples in medicine, nursing, and surgery that affected the signature of pedagogy (Shulman, 2005). In spite of the fact that Shulman did not note the possible changes in the arts, we can assume the future changes of the signature pedagogy in

music based on the research works that propose moving from the wood past to the digital future in this field. Researchers pointed out the transformation of musical professions such as composer, performer, and conductor due to the digitalization process, wherein all the traditional roles can be replaced by computers (Karkina et al., 2020). Obviously, digital tools have become more valuable in the field of music education now than they were several decades ago, which is why the implementation of the signature pedagogy of music teaching by means of online learning needs to be studied in the context of this issue.

Online technologies for teaching music remotely

The digitalization process in music education has increased in the last few decades. Modern universities promote massive online courses for learning music without social, location, or time limits. The educational platform Coursera offers a wide range of music courses that provide study of music history and theory: "Introduction to Classical music" (Yale, USA), "The world of the string quartet" (Philadelphia, USA), current trends in music teachers' professional activity: "The Place of Music in 21st Century" (Sydney, Australia), as well as training musical composing and performing skills such as "Write Like Mozart–An Introduction to Classical Music Composition" (Singapore), "Jazz improvisation" (Berklee, USA), "Developing your musicianship" (Berklee, USA). The Massive Open Online Courses (MOOCs) present a new model of distance learning (Blackmon, 2018) that provides accessibility, flexibility, and interactivity in education globally (Olmos et al., 2015).

A wider possibility of training musical performing skills remotely was challenged by researchers (Karkina et al., 2021). In the recent past, the experiment of teaching piano by Skype was organized (Pike, 2017), which was the first attempt in the area and was conducted in a limited context. Without the involvement of face-to-face interaction, this process showed advantages in delivering music lessons online for students who are deprived of the opportunity to learn music. Another project was carried out in England to widen the participants' musical education. The study included instrumental lessons for students and courses for continuing professional development for teachers, both using camera and high-quality audio. The research stated the benefits of using a multi-camera setup for delivering lessons (King et al., 2019).

The emergency of the COVID-19 pandemic noticeably strengthened the online practice of teaching music. To overpass the negative financial effect of a lack of face-to-face musical shows, musicians prioritized online performances for capturing their audience's attention (Rendell, 2021). The teachers in rural communities faced a multitude of challenges during the pandemic period (Johnson and Stanley, 2021). The research of their online teaching experience allowed them to note two categories of issues, which are settings and place-based pedagogy that have influenced the practice. Based on the results of the qualitative study, the online delivery methods including differentiation of the teaching contexts and geographic settings were stated (Johnson and Stanley, 2021). Summarizing the pandemic and post-pandemic research, the process of re-examining the teaching approaches and redesigning music courses was noted. For the purpose of improving the effectiveness of online music education, scholars are searching for active learning methods and the design of the online environments (Phipps, 2021).

Modern researchers describe a wide range of online courses, such as MOOC, BOOC (Big Open Online Course), DOCC (Distributed Open Collaborative Course), LOOC (Little Open Online Course), MOOR (Massive Open Online Research), and SPOC (Small Private Online Course) (Naert, 2015). While MOOCs are recommended as a supplement to classroom teaching, in cases where a teacher needs to increase the time of personal interaction with students, their mastery, and engagement, a Small Private Online Course (SPOC) could be more suitable (Fox, 2013). In contrast to the global availability of MOOCs, access to SPOC is managed by the teacher and can include automatic grading such as online tests or quizzes (Ziebarth and Hoppe, 2014). Besides, in SPOC, each student receives personal interaction with human teaching assistants and, above all, has the "opportunity to resubmit homework to improve on their previous score and increase mastery" (Fox, 2013). The implementation of the online flipped classroom in school music teaching became highly relevant during the pandemic. For engaging students in creative making with instrumental music, combining online with face-to-face lessons allows enhancing the satisfaction and knowledge acquisition (Ng et al., 2022). With regard to using SPOC, we have found research in the field of teaching music history only (Jing, 2018), while practical issues such as delivering theoretical knowledge were not covered by them.

The adoption of synchronous and asynchronous learning methods by using e-sources has become the leading education science trend for the last few decades (Armellini and Aiyegbayo, 2010). For these purposes, scholars apply the open-source learning management system (LMS) and design online courses based on Moodle (Kampa, 2021). Scholars note that remote learning is not similar in structure to the traditional classroom (Salmon, 2013), and instead of face-to-face interaction, it provides another form of student–teacher work in a synchronous or asynchronous way. Salmon pointed out that the content of an online course including learning resources and any other materials provided stimulus for interaction but needed additional tools to focus student's activity. Highlighting the importance of e-tivity, he called it a "break point from the time-consuming 'writing' of online courses" (Salmon, 2013). The design and delivery of e-tivities could enhance the student's engagement in the online musical performing activity, but at present, we need to state the gap in this area. While overviewing research on online music teaching by fostering student's skills through e-tivity, we did not find the works that studied this issue as well as signature pedagogy in learning music; thus, bridging this gap could bring significant advantages for music education.

Objectives

Based on the background study, the general aim of the research was stated as follows: how and which students' music teacher

professional skills are affected in the process of online learning based on the signature approach?

To achieve the general aim of the study, three research questions were determined:

- *RQ1* How can music teacher signature pedagogy be identified based on Schulman's theory?
- *RQ2* Does the music teacher signature pedagogy implemented by SPOC affect students' learning and engagement?
- *RQ3* Are future music teachers' professional skills associated with student's e-learning based on the signature pedagogy approach?

Future music teachers' remote training based on signature pedagogy using e-learning

Signature pedagogy in music education

Schulman in his study of professional education noted, "It's very hard to learn to practice without powerful consistent models" (Yendol-Hoppey and Franco, 2014). In this quote, Shulman identified the lack of powerful consistent teaching models and pointed out the research trend in the field of professional development for schools. To bridge this gap in the field of music education, the signature pedagogy for preparing music teachers was identified.

Following Schulman's definition, three dimensions of a music teachers' signature pedagogy were identified. The first level is the surface structure, "which consists of concrete, operational acts of teaching and learning" (Shulman, 2005, p. 54), which is defined as the process of a set of dialogues of authoritative teacher who is commenting on students' artistic exercises. A teacher encourages students to experiment with music and collaborate with each other. Also, students create artistic performances and comment on the works of their classmates. The most significant part of the process is training student's musical skills but the stimulation of their artistic creativity is also important. The instructor mediates the activity in the class, critiques and challenges, or just observes. The knowledge provided by the teacher serves as a base for creative musical experiments.

The second level, according to Shulman's theory, is the deep structure of the pedagogy that rests on the assertion that what is really being taught is the theory of music pedagogy and how to think as a music teacher (Abdullin and Nikolaeva, 2006). The subject matter consists of the relevant problems and the gaps in music education currently. Students learn to identify such problems and develop new teaching strategies and tools, which will be implemented in the school in the future. The music pedagogy theory is about the contradiction between classical music standards and real student's abilities that they demonstrate in the lesson, hence the inherently challenging and groundbreaking character of critique dialogue as pedagogy.

The third level of music teacher signature pedagogy, i.e., the implicit structure, has several features. The most questionable issue discussed among teachers and students who are preparing for the role of specialist is the dichotomy of personality and standardization. Because music lessons are mandatory at general school for all the children, regardless of their natural potential, the criteria for assessment become too brutal for some of them. Very often, children's natural inability to satisfy all the requirements of the school program provokes their unwillingness to engage in music. In such a context, teacher is asking himself, what is the main goal of the school music lesson? Is student's self-perception of music additions the only or the main result? In other words, does a teacher have the right to correct the criteria to allow students to look for his or her personal way of interacting with music? This distinction between the standards and the unique nature of personality emerged from the pedagogy as a tacit principle. These lessons might also be called the hidden curriculum of a future music teacher's preparation process.

Following the structure of Schulman's theory, the missing elements of signature pedagogy may be examined. The missing signatures here are the pedagogies of intellectual training. While these pedagogies can be found in all music classes in the general school, they are typically on the margins of the enterprise, are rarely required, and are often ungraded. Most teachers stimulate music activity by singing and playing musical instruments but do not pay enough attention to deep knowledge, including historical facts or the theoretical background of some music phenomena.

Shulman distinguishes "three fundamental dimensions of professional work-to think, to perform, and to act with integrity" (2005) that correspond, respectively, to one of the leading trends featured as training of the mind, hands, and hearts. In other words, these dimensions point to the focus of the learning practice: the intellectual, the technical, and the moral.

Shulman does not mention in his works the music teacher's profession directly. Taking into account that music teaching refers to the general area of art education, we can find art education and the education of clergy in the same row in the quotations of Shulman's works. With respect to the clergy education routines, Shulman has emphasized the development of habits of the heart, so indirectly we can assume the music teacher education featured is the same. Critically analyzing the core of the future music teacher educational process as the process of engaging students in the experimentation and collaboration that is observed, criticized, and commented on by the instructor, this assumption seems to be correct. Arguing the possibility of training the students' hearts without personal face-to-face interaction with an educator poses challenges in the implementation of the music teachers' signature pedagogy in the digital environment and calls for addressing this issue.

Implementation of the music teacher signature pedagogy in the online learning practice

To enhance the professional training for preparing future music teachers online in the case of emergency like COVID-19 pandemic, a small private online course (SPOC) based on the signature pedagogy was designed. The structure of this course was based on Shulman's three fundamental dimensions: surface, deep, and implicit structure. The course was implemented on MOODLE.

Considering the definition of the surface structure as the forms of interaction among a teacher and students in the online

course, the tools for the full set of schoolchildren's music activities according to the standard of music education (Abdullin and Nikolaeva, 2006) were provided. In the process of training vocal and instrumental performing skills, students recorded themselves in their self-preparing practice and sent these records to the teacher for feedback and recommendations for improvement. A similar way was used for training group performance skills. In addition, students made records using telematics technology, which allows creating the voices of the ensemble sequentially. For training creative skills, the task of creating musical compositions of poetry with music was suggested. The skills of listening to music, understanding, and evaluating were trained by means of essays. Students had been listening to the recordings loaded into the online course. Following the instructions from the resource, they wrote and sent via e-source "task" their works. A close student–teacher interaction was organized by means of workshops, forums, and chats that allowed the teacher to pay personal attention to each student. The group worked on the workshop, and the participants discussed and commented on their music experiences.

The deep structure, targeted at the teachers' reflection of professional experience and development of powerful methods, was implemented in the form of project work. Students received the personal university teacher's consultation for the chosen research trend for the project work through online meetings. The instructions about formal details on how to prepare the project were delivered by the teacher online and by means of the resource "lecture" in the online course. Based on the theoretical background, students designed didactic improvements for the general school educational process. While assuming the role of a music teacher, students had been creating new methods and means to foster schoolchildren's musical skills. Some of these projects were implemented in real schools. The web and digital sources including subject Internet sites, books, and articles provided by SPOC were useful for this work.

The implicit structure, defined as the specific forms of learning activity, was organized through the online discussions and challenges. The online meetings with school teachers and videos of music lessons in schools encouraged students for professional self-improvement and inspired them. By discussing with teachers, students got the opportunity to develop their awareness of music teacher values, attitudes, and dispositions. The discussions of critical issues, which are strongly relevant in modern general school music education, had taken pivotal role. The arguing of actual problems and the discussion of contrary arguments to promote effective solutions were organized in online workshops and offline forums. The teacher suggested arguing current topics from social reality, such as the social status of a music teacher, music art in the digital age, creative activity in the music lesson, and standardization in music education. Through all these forms of activity, student's engagement in the music teachers' professional practice increased through the fostering of awareness of moral aspects of real school practice.

The SPOC based on signature pedagogy allowed to gather in one course systematically the professional competence of music teachers. The fundamental set of general schoolchildren's activities in music class and three levels of Shulman's signature pedagogy for promoting professional knowledge, skills, and the ability to work with integrity allowed to provide the interactive online training environment. In regard to the Shulman definition of teaching in art as training of the heart, the effectiveness of the online educational process should be tested by means of research methodology.

Materials and methods

Study design

The research work was carried out at Kazan Federal University and approved by the Human Ethics Advisory Group by using the Ethical guidelines for educational research proposed by the British Educational Research Association [BERA] (2018).

The organizing process of the study included several types of activities by students and teachers throughout the academic year. Regular education processes were conducted on the platform MOODLE by using online and offline ways. During this process, teachers facilitated student's learning practices by:

1. Organizing online workshops for the explanation of the learning tasks to students.
2. Stimulating students' engagement and effective self-improvement in performing skills by providing comments and recommendations.
3. Organizing the online meetings with schoolteachers for sharing their professional experience and giving interviews to students.
4. Discussing the current problems and challenges in the music education school's practice.
5. Consulting students in the project work.
6. Evaluating students' musical records with solo and group performances, their creative musical works, and projects.

During the learning process, students have been trained in the full set of music teacher professional activities including playing musical instruments, vocal singing, solo and group performance, listening to music and analyzing it, composing, improvising, working on a project, writing essays, and discussing. This set of activities was structured in the online environment based on the music teachers' signature pedagogy.

All artistic works and projects prepared by students were evaluated by an expert board that included the most respected teachers from the University department of the Institute of Philology and Intercultural Communication. Based on this assessment, the results of the students' performances, creative artistic works, and projects were determined.

At the end of the academic semester, an additional study was carried out to inquire about the satisfaction among teachers and students of online training in music teacher professional skills. All the students were involved in this work. Teachers who had been working with them and the expert members were asked about their personal preferences and perceptions regarding the training process and results. Based on the opinions of students, teachers, and expert members, as well as background knowledge in this educational field, a comparative analysis of traditional face-to-face and online learning for future music teachers based on the signature pedagogy approach was carried out.

Research methodology

Dimensions and categories of analysis

The analysis performed in this work relies on a multi-case study methodology that was considered the most appropriate research strategy to deeply understand the issue through a meticulous analysis (Cohen et al., 2007). This type of analysis allows to replicate the study of the phenomenon in different contexts (Yin, 2014), making it possible to make comparisons of the results. The study let to gather multiple data sources—documents, questionnaires, interviews, and observations—guaranteeing the fulfillment of the experimental data (Lima, 2020). Each case represents a different course where SPOC based on signature pedagogy was implemented.

For each course, the analyzed dimensions and categories are summarized in Table 1. The first dimension of analysis, Didactical Implementation, intends to characterize the intentions of the University teachers in designing the SPOC based on signature pedagogy and perceptions of the implemented online learning. The second dimension, Students' Results, features three categories: students' academic performance, the development of their music teacher professional skills, and self-perception about the online learning educational process.

Starting with the category SPOC's implementation, the factor "Number of tasks in SPOC" shows how many different tasks were used by students in the group. The next factor, "SPOC tasks attribution," allows us to clarify their type. There are four general types of tasks featuring student's online activity: perception (Pr), performance (Pf), creation (C), and research (R). The SPOC usage within a course ("SPOC use level") was classified into three levels: basic (B), intermediate (I), and advanced (A) according to the student's mastery within the online environment (B: reading and listening; I: doing tasks; A: interactive). The "course level" may be distinguished into four types according to the number of academic years of student groups.

In the category Teachers' perception, the factor of "teachers' satisfaction with the SPOC" was assessed on a 5-level Likert scale from absolutely satisfied to fully unsatisfied.

For the category Academic performance, four factors were studied: "students' background in using online courses" was assessed by the 3-level Likert scale: First experience (1); Used in the past (2); and Active user of different e-sources (3). The students' assessment of the course as per the curriculum was marked in the category "students' grades." The factor of "students' success" considered the number of students who did not demonstrate the positive assessment on the final exam (NF) or had dropped out of the course (dropout). The "students' access in SPOC" was noted by means of the technical tools of MOODLE, where any user can find the duration of the period and type of activities of any participant, and assessed by four points: daily (4), once every 2–3 days (3), once a week (2), and once a month (1).

The category Professional development reflects the music teachers' professional activities. The majority of them were included in the experimental list and assessed through the online studying process using a 10-level Likert scale depending on the student's mastery.

In the category Students' perception, three factors were obtained: "learning with SPOC," "satisfaction with SPOC," and "satisfaction with support" by a questionnaire that was delivered to the students at the end of the academic year.

Data collections and participants

The research work had taken place at Kazan Federal University. Due to complete shift of the education process to distance learning in the period of pandemic COVID-19, all disciplines were studied online, including specific musical courses that were traditionally taught in face-to-face classrooms.

The future music teachers' curriculum includes the hours for the special practicum, in which students are trained in the standard set of music teachers' professional skills. These hours offer a sort of practice for studying the real profession in all its complexity. Depending on the students' year of study, this part of the curriculum provides different types of courses that cover instrumental and vocal performance, music analysis, creativity, and project work. This work supports the transition from the role of student into the professional role of teacher (Woeste and Barham, 2006). All the components of this practice were covered by the music teachers' signature pedagogy implemented in online learning by means of SPOC.

For the research work, 124 students from the 1st to 4th years of study were involved. Part of them participated in the full-time (F) and part-time (P) regimes. All of them were studying for the future music teacher bachelor's program. According to the curriculum, each group studied the academic course from the section on music teacher professional practicum. That is why the learning context of each group was different and was classified as a case. These cases and courses are demonstrated in Table 2. Data were collected from one academic semester during 1 September 2021 to 31 May 2022.

The experimental process involved three teachers who had been working with students and four members of the expert board who provided the final assessment of the musical performances and projects presented by students. All the teachers involved in the study were females. The indicator of teachers' age was divided into three periods (35–41, 42–55, 56–60 years). One of them had graduated in higher education, while all others had got candidate degree. University teachers have different duration of experience in teaching online and usually older among them have less experience in using online courses.

At the end of the academic semester, the students who participated in the online practicum and the teachers and experts, who worked and assessed them, were asked to fill out the feedback survey forms. In total, 84 filled-out forms from students and seven from teachers were received and analyzed.

Measures and methods

Considering the aim of the research, the multi-case study research methodology was chosen, and quantitative and qualitative data were combined using a mixed method approach, resourcing mainly questionnaires, interviews, documental analysis, and observation as data gathering methods and descriptive statistical analysis as data analysis techniques.

TABLE 1 Dimensions and categories of analysis.

Dimensions	Categories	Factors	RQ1	RQ2	RQ3
Didactical implementation	SPOC implementation	Number of tasks in SPOC	*x*	*x*	
		SPOC tasks attribution	*x*	*x*	
		SPOC use level	*x*	*x*	
		Course level	*x*	*x*	
	Teachers' perception	Teachers' satisfaction	*x*	*x*	*x*
Students' results	Academic performance	Students' background in using online courses	*x*	*x*	
		Students' grades	*x*	*x*	
		Students' success	*x*	*x*	
		Students' access in SPOC	*x*	*x*	
	Professional development	Instrumental performing solo and in ensemble	*x*	*x*	*x*
		Vocal singing	*x*	*x*	*x*
		Analyzing of music	*x*	*x*	*x*
		Creativity by music	*x*	*x*	*x*
		Knowledge of music history and theory	*x*	*x*	*x*
		Project design	*x*	*x*	*x*
	Students' perception	Learning with SPOC	*x*	*x*	*x*

TABLE 2 Case study characteristics.

Case#	Regime	Academic level	Program titles	Students				
				Total number	Gender		Age	Experience in using online courses
					M (%)	F (%)		years
C1	P	1	Listening to music Instrumental training Vocal ensemble	26	5 (19.2)	21 (80.7)	18–22	0–1
C2	P	2	Instrumental training Vocal ensemble	23	1 (4.3)	22 (95.6)	19–23	0–1
C3	F	3	Instrumental training Vocal ensemble Improvisation Project work	19	1 (5.2)	18 (94.7)	20–22	1–2
C4	P	3	Instrumental training Vocal ensemble Music Analysis Project work	36	3 (8.3)	33 (91.6)	22–26	1–2
C5	F	4	Instrumental training Vocal ensemble Children' creativity Project work	20	5 (25)	15 (75)	21–25	1–2

The teachers' interview script was composed of seven closed questions with three answer options (*no, perhaps,* and *yes*) and a final open question asking for the main advantages/disadvantages of this resource (What advantages and disadvantages do you find in the use of signature pedagogy SPOC?). These interviews are intended to evaluate teachers' usage and satisfaction with SPOC, including the didactical aspects and SPOC's main disadvantages/advantages.

The study of the educational documents provided significant experimental data. For research purposes, a multitude of types of educational records were provided, including timesheets, plans, curriculum, technical information, and grade reports. The academic documents of student's grades and success in passing the exams can be used as approval of the responses from the interview, which students completed at the end of the study process. The documents obtained within the research context included:

- Information about students' performance: detailed academic results (grades by component, final grade, number of students who did not fulfill the assessment during the semester, number of dropouts).
- Information about SPOC usage: number of SPOC accesses for students.

The ultimate goal of the analysis was to characterize the SPOC didactical implementations as well as students' academic performance and SPOC usage thoroughly. To protect the anonymity of participants in the project, all names were withdrawn and replaced by aliases.

The evaluation of students' musical performances by members of the expert board was carried out by the method of average rating. Using the list of criteria, each student was assessed on a 10-level Likert scale (from 1 as insufficient to 10 as excellent). The statistical approval was made by the standard deviation in order to establish the difference among the evaluation results of the expert board members.

The students' academic performance and perception of SPOC were studied by a semi-structured questionnaire: a combination of a set of closed questions (10) on a scale through which the respondents express their degree of approval or rejection about a given statement by using the quantitative measure and open questions (2) designed to capture students' insight about a particular issue. The closed questions were composed on a 5-level Likert agreement scale (1: I totally disagree; 2: I partially agree; 3: I rather agree; 4: I agree; and 5: I fully agree). Two open questions clarified the students' satisfaction with learning through SPOC: What did you enjoy most about using SPOC? (Q11). What inconveniences did you find during your study of the SPOC? (12). At the end of the course implementation, students' opinions about the didactical experience and the main advantages/disadvantages of SPOC were collected. The student's satisfaction questionnaire was delivered on paper (in most cases) or made available via Moodle or Google Forms as per requirement. For the sake of correlating students' answers with their academic results, students were asked to identify themselves through their academic ID numbers, which were codified by their teachers in order to guarantee students privacy. It was explained to students that this identification was purely for research issues.

The questionnaire used closed-ended questions, and three factors of analysis were identified and studied:

- F1: Students' perceived learning with SPOC. It features the student's self-assessment of the effectiveness of online music learning, including theoretical studying and training performance skills, as well as interacting with other participants. It was addressed using questions Q2, Q5, Q6, and Q8.
- F2: Students' satisfaction with SPOC. It refers to SPOC usage (availability, accessibility, ease, and suitability) and the perceived most value, as well as asking for students' preferences between this type of resource and face-to-face classes. It was addressed using questions Q1, Q3, Q7, and Q10.
- F3: Students' satisfaction with support. It expresses students' perceived assistance toward the MOODLE system: the LMS course page (support material, forums, etc.), SPOC manuals, teacher guides, as well as server issues and/or Internet connection. It was addressed using questions Q4 and Q9.

A reliability analysis (Cronbach's alpha, also referred to as the alpha coefficient of reliability) of the three factors, previously described, was performed. This step is essential to ensure the validity of the studied variables as Cronbach's alpha that "provides a coefficient of interitem correlations, that is, the correlation of each item with the sum of all the other relevant items" (Cohen et al., 2007). This is a measure of the internal consistency among the items, that is, a way of realizing whether items on a variable's measurement scale measure the same construct. The coefficient ranges from 0 to 1, and the closer to 1, the more reliable the items that make up the scale; it is unacceptable if Cronbach alpha is <0.5 (Pestana and Gageiro, 2014).

The results from this test are displayed in Table 3. The table displays these results by case—for each group where SPOC was implemented. The last line in Table 3 presents the global results, considering all the collected data (from all students involved in all didactical implementations). The former table includes the case number and course names as well as the number of students enrolled in each course (N St). Considering the analysis by case, it shows internal consistency in F1, F2, and F3 for the majority of the cases (even though at a low level, for some of them).

The quantitative data from the interview of teachers and student's questionnaires, as well as technical data about didactical implementation characteristics, were analyzed by the descriptive statistical method of the Pearson's chi-square test (χ^2), or the chi-square test. This test is commonly used for studying the relationships between categorical variables to determine whether an association exists between the two variables by comparing the observed distribution to the expected one if the variables are really independent of each other (Lima, 2020). If $p < 0.05$, one can conclude that the variables being studied are not independent of each other and there is a statistical relationship between them (Cohen et al., 2007).

Considering the vast amount of qualitative data, in this research work, content analysis (Cohen et al., 2007) has been used for the majority. The open questions (SPOC main advantages and disadvantages), both for the student's satisfaction questionnaire and the teachers' interviews, were qualitatively analyzed, following the procedure of the grounded theory (Glaser and Strauss, 2012). This theory does not limit the interpretation to already known theories but rather builds conclusions from the analysis of the collected data, respecting their shades and diversity in the construction of categories and subcategories (Cohen et al., 2007). In this study, the grounded theory allows to look for semantic clusters within responses in spite of the minor variants with which they were formulated or the internal aspects to which they refer (Lima, 2020). Therefore, it quantifies not the number of students/teachers but the ideas expressed by them as one person may have pointed more than one argument as regards interest and/or difficulty (Lima, 2020). The qualitative analysis of what teachers and students reported helped build the analytical categories. This analysis was performed independently for the two types of respondents: teachers and students.

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TABLE 3 Student's questionnaire internal consistency analysis (Cronbach alpha), by case.

Case #	Program	Course names	N St	F1	F2	F3
C1	P	Listening to music Instrumental training Vocal ensemble	26	0.554	0.355	0.556
C2	P	Instrumental training Vocal ensemble	23	0.643	0.521	0.367
C3	F	Instrumental training Vocal ensemble Improvisation Project work	19	0.747	0.849	0.433
C4	P	Instrumental training Vocal ensemble Music analysis Project work	36	0.272	0.588	0.574
C5	F	Instrumental training Vocal ensemble Children' creativity Project work	20	0.366	0.378	0.243
Total			124	0.516	0.538	0.434

TABLE 4 Didactical implementation characteristics.

Case #	SPOC implementation			
	Number of tasks	Attributions	Level of use	Course level
C1	3	Pr	B	1
C2	5	Pf, C	I	2
C3	9	Pf, C, R	A	3
C4	8	Pf, C, R	A	3
C5	14	Pr, Pf, C, R	A	4

Results

Didactical implementation

The first dimension of "Didactical implementation" was presented by two categories: "SPOC implementation" and "Teachers' perception." The study of the first one was realized through the analysis of the technical data in the MOODLE environment and academic documentation.

Teachers introduced and used SPOC in their courses, which varied significantly in contents and level of difficulty; some of them were introductory courses (students' first training in professional skills) and some were advanced ones, taking into account the learning goals they wanted to achieve. They intended to design tasks according to the professional skills that music teachers wanted to develop in their students. Table 4 summarizes these implementation characteristics.

The number of tasks that were mandatory for students to complete varied between 3 and 14, from low to high levels of academic study, respectively. An increase in the number of task types in accordance with the course level from first to fourth was also observed. Depending on the course level, the student's mastery of usage within the course increased in accordance with the complication of educational tasks.

In regard to the second category, the teachers' and experts' perceptions of the online work with students were studied through interviews. The quantitative results for the Teachers' interview, which included closed-ended questions, are presented in Table 5. The results demonstrate that more teachers/experts found the remote way easy to use rather than complicated. Moreover, for most of them, this method was not as time-consuming in comparison with the traditional face-to-face class. Mostly, they assessed the components of SPOC as suitable for the teaching/experting needs, but with respect to the interactivity, less numbers featured it as high enough. In general, we noted the satisfaction of teachers and experts about student's learning outcomes. However, not all the faculty found the interface of the app user-friendly, and many of them met with gaps in the Internet connection during the educational work.

The qualitative analysis of the open-ended questions of the teachers'/experts' interview allowed us to identify five factors, directly considering teacher satisfaction: three positives and two negatives. Table 6 summarizes these factors according to the main advantages and disadvantages of SPOC for staff. More than half of teachers/experts identified the opportunity for students' productive self-preparing practices. Less numbers mentioned the possibility of interacting with students personally, while most of the staff stated the advantages of diversifying of teaching methods. However, teachers emphasized the need for sufficient experience in using online tools, and many of them pointed out the simplification of the interface of the MOODLE environment in comparison with modern computers and mobile educational Apps.

Students' achievements and SPOC perception

The ultimate goal of any didactical implementation is to improve student's academic performance, measured directly by

TABLE 5 Teachers'/experts' interview results.

#	Questions	Total number of respondents	Answer options (%)		
			Yes	Perhaps	No
1	Was the teaching/evaluating students remotely easy?	7	57.1	28.5	14.2
2	Was the online work time-consuming in comparison with your regular class?		14.2	14.2	71.4
3	Were the components of SPOC suitable for your teaching/experting needs?		71.4	28.5	-
4	Did the SPOC provide high level of interactivity?		42.8	42.8	14.2
5	Did you satisfy of the students' learning outcomes?		57.1	28.5	14.2
6	Was the app interface user-friendly?		28.5	57.1	14.2
7	Did you never have problems with the Internet connection?		42.8	-	57.1
8	What advantages and disadvantages do you find in the use of signature pedagogy SPOC?		(Open question)		
Total			44.8	28.5	26.4

TABLE 6 Teachers'/experts' open question quality assessment (positive and negative factors).

#	Quality	Replies	Frequency (*N*)
1	Positive	Intensification of students' self-preparing practice	5
2		More time for personal interaction with each student	4
3		Diversify teaching methods	6
4	Negative	The process required enough experience with the online tools	2
5		Interface old fashionable/too simple	4

their grades and/or by other important determinant factors (Lima, 2020). The study of the correlations between student's SPOC usage and perception of the tools and their academic results, as well as access to the resources and satisfaction, should be considered. The dimension of "Students' results" was covered by three categories: "Academic performance," "Professional development," and "Students' perception."

The study of the first category was based on the student's replies in the questionnaire, which were compared with the academic documents. These results presented in Table 7 demonstrate the gradual increase in groups from first to fourth academic level for all criteria. At the same time, a slight decrease in the results of fourth year students, especially in criteria of grades and access, shows a decrease in graduate student's engagement with the learning process, while the value of their background in using online courses increases. In all cases, the standard deviation indicator is in the interval from 0.1 to 1.7, which is very close to 1 and confirms the similarity among the received data for each student's cohort.

In regard to the category of "Professional development," the student's learning outcomes were assessed by members of the expert group using a 10-level Likert scale (Table 8). The results demonstrate a high enough level of developed skills (the total median is in the period 5–9). The standard deviation confirmed the absence of a statistically significant difference between each student's evaluation for each criterion (all the results are in the interval 0.3–1.7).

The questionnaire allowed to clarify the student's perception of learning by SPOC that they filled out after completing the online tasks. From all the cohorts that participated in the experimental study, only 84 (>50%) persons returned the filled-out forms. Table 9 shows that a large number of students (28.5, 33.3, and 19.0) agree that SPOC is an effective tool for musical training. A smaller number of students agree that the presented resource does not need improvements (11.9, 17.8, and 42.8). But most of the students were satisfied with the support provided by staff in the online learning (17.8, 41.6, and 29.7).

The qualitative analysis of open-ended questions in the student's questionnaire: What did you enjoy most out using SPOC? (Q11), What inconveniences did you find during your study of the SPOC? (Q12) allowed to identify six factors directly considering student's satisfaction: four positives and two negatives. Table 10 summarizes these factors. More than half of the students emphasized the comfortable conditions of learning from home and the variety of tools; approximately half of them noted the opportunity to manage their time and have productive training. However, half of all the respondents mentioned the gaps in home Internet, and a smaller number of students pointed out the outdated interface of MOODLE.

Online tools for training of music skills

The next step of the experimental work was an attempt to establish some SPOC task characteristics, including student's activity in the online environment, which affects the improvement of their music teacher professional skills. The correlation between features of SPOC usage and student's grades of professional development was determined and presented in Table 11. Pearson's chi-square test (χ^2) correlation analysis was used to determine whether there was a correlation, considering each former factor with the test variables that somehow reflect students' results.

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TABLE 7 Students' academic performance results.

Case #	SPOC implementation							
	Students' background in using online courses		Students' grades		Students' success		Students' access in SPOC	
	Median	St.d.	Median*	St.d.	Median**	St.d.	Median	St.d.
C1	2	0.125	86	0.244	2	0.198	1	0.937
C2	2	0.223	88	0.652	2	0.922	2	1.522
C3	3	0.562	89	0.155	2	1.247	4	0.487
C4	3	0.622	74	0.734	2	0.934	3	1.746
C5	3	0.572	82	0.478	2	0.142	2	1.564

*According to the academic curriculum evaluated by 100-level grade. **In relation to the academic results could be assess on a 2-level Likert scale: 1-dropout, 2-positive assessment on the final exam.

TABLE 8 Students' professional development results.

Criteria		Cases				
		Case 1	Case 2	Case 3	Case 4	Case 5
Instrumental performing solo and in ensemble	Median	7	8	9	8	10
	St.d.	0.355	0.627	0.998	1.367	1.342
Vocal singing	Median	6	7	10	9	10
	St.d.	1.473	1.253	0.958	1.573	0.489
Analyzing of music	Median	4	5	7	6	7
	St.d.	1.573	1.245	0.938	1.736	1.253
Creativity by music	Median	3	4	6	5	8
	St.d.	1.837	1.490	0.598	0.958	0.488
Knowledge of music history and theory	Median	5	6	8	8	9
	St.d.	1.733	1.374	1.121	1.475	1.167
Project design	Median	-	6	8	7	9
	St.d.	-	1.483	1.132	1.476	1.387
Total	Median	5	6	9	7	9
	St.d.	1.187	1.245	0.957	1.430	1.021

TABLE 9 Students' perception results.

No	Factors	Number of students	Answer options (%)				
			I fully agree	I agree	I rather agree	I partially agree	I totally disagree
1	Learning with SPOC	84	28.5	33.3	19.0	14.2	4.7
2	Satisfaction with SPOC		11.9	17.8	42.8	19.0	8.3
3	Satisfaction with support		17.8	41.6	29.7	8.3	2.3

The analysis found a positive correlation in most comparisons, while some of them showed a weak negative correlation. The strongest correlation was noted for the number of tasks on which students worked and the regularity of their access to MOODLE environment. A less strong correlation was mentioned for factors such as level and background of using online courses, so they are not mandatory for musical development. A negative correlation was found between the factors of using computers (background and access) and performing skills improvement (instrumental and vocal). For these two factors, self-training is critically important. After long hours of playing an instrument or singing, students load the record in the MOODLE environment, and this does not take as much time as previous self-practice.

Discussion

Considering the study and looking at the problem through the lens of Shulman signature pedagogy it seems to be critical to point out a new challenge. According to the definition of signature

TABLE 10 Students' open question quality assessment (positive and negative factors).

#	Quality	Replies	Frequency (*N*)
1	Positive	Learning from home is very comfortable	56
2		To manage my time for the learning process	43
3		Productive performing practice	45
4		More variety of study options and tools	78
5	Negative	The gaps of the Internet access	42
6		Interface old fashionable	26

pedagogy among the fundamental dimensions of professional work–to think, to perform, and to act with integrity, the last one, featured for art and clergy should be studied in more detail from the aspect of digitalization. This assumption (clarify) is based on the contradiction between computer and personality. Following Shulman, the core of some professions such as music, clergy and arts is the training of "heart" and calls for development of high responsibility in the moral aspect. This statement is confirmed by argument of scholars regarding need for redirection culture that is away from economic prescriptions so as to focus on social values (Bailey et al., 2019). Such qualities need to be transmitted directly from person to person through their face-to-face contact. In a case of lacking personal interaction, the possibility to provide significant information could be seriously limited.

In the recent past research pointed out relevance of e-learning as a progressive way for education without limits (Kumar et al., 2018). Even earlier, scholars have suggested the trend of personalization in remote teaching by upgrading the online tools and including innovative type of online courses (Fox, 2013).

The experimental work lets us state in general the positive impact of online learning on future music teachers' professional skills based on the signature pedagogy. Doubtlessly, music education cannot be fully shifted in a remote way, but for some reasons, such as emergencies when face-to-face class interaction is not feasible, digital tools could bring critical advantages. In these frameworks, the approach to teaching should be chosen thoroughly in order to systematize the professional training tasks and implement them in the online environment.

Currently, digital technologies tend to redesign music education noticeably. While the computer lab is transforming into an effective instrument of music-making, it gets real functions to replace traditional professions such as composer, performer, and conductor. This transformation can radically change the structure of music education, making some of its levels available to a very small cohort due to their high cost. At the same time, modern musicians, who work near computers, state the benefits of digital tools in comparison with traditional music learning. They argue that the digital tools provide a simple way for creating music as well as correcting it (Turchet et al., 2018). Also, the digital environment presents opportunities for self-studying music that becomes crucial in cases of restrictions or limitations.

Considering this issue and looking at the problem through the lens of Shulman's signature pedagogy, it seems critical to point out a new challenge. According to the definition, among the fundamental dimensions of professional work—to think, to perform, and to act with integrity—the last one, featured in art and the clergy, should be studied in more detail from the aspect of digitalization. This assumption is based on the contradiction between computer and personality. Following Shulman, the core of some professions, such as music, clergy, and arts, is the training of "heart," which means the development of high moral responsibility. Such qualities need to be transmitted directly from person to person through face-to-face contact. In the absence of personal interaction, the possibility to redirect the pivotal information could be seriously limited.

In such a context, the design of online courses appears from a new research perspective that requires to distinguish subject fields through the lens of the future specialist, preparing goals for appropriate methodology and effective digital tools. The signature pedagogy presents a fundamental theoretical approach for studying professional pedagogy. Moreover, it points out the critical features of professions and declares the teaching strategies. Based on this study and taking into account the increase in global digitalization, the necessity of developing educational instruments in music as well as far beyond it (arts, clergy) should be determined in the frames of the computer-personality dichotomy.

Conclusion

The presented study demonstrates that technologies of remote teaching such as e-learning can replace face-to-face learning in a case of emergency in the field of music education. In the recent past main aspects of online music teaching were studied including training personal performing skills and group performance through online collaboration, delivering music knowledge to remote communities, implementation in the educational process of high-quality digital tools. However, lack of knowledge in the field of online musical professional training was a problem in higher education particularly in the process of preparation of future music teachers. In order to eliminate this problem, the signature pedagogy approach was implemented. This approach proposes the fundamental study of professions and allows improving the music teaching at university by implementing the pivotal professional features through the online tools.

The results of this research work conclude that technologies of remote teaching such as online courses can replace face-to-face learning in a case of emergency in the field of music education. The music teachers' signature pedagogy is featured by the music activity (surface structure), improvements to the school practice (deep structure), and analysis of the values (implicit structure). The core of this pedagogy is the personal interaction between a teacher and students to transmit the moral dimension through the subject. The choice of the small private online course (SPOC) as a type of online technology justified the specification of the music lesson and the music teacher's competencies, which should be learned by students at university.

The obtained results demonstrated the effectiveness of the designed course. Both research questions were confirmed by data collected using quantitative and qualitative methods. Considering RQ1 and RQ2, it was stated that the music teacher signature pedagogy implemented by SPOC really affects student's learning and engagement. With respect to RQ3, the music teacher's

TABLE 11 Correlation between online activity and professional development results.

Factors	Professional development results					
	Instrumental performing	Vocal singing	Analyzing of music	Creativity by music	Knowledge of music	Project design
Number of tasks	$R_{SP} = 0.281$ ($p < 0.001$)	$R_{SP} = 0.221$ ($p < 0.001$)	$R_{SP} = 0.352$ ($p < 0.001$)	$R_{SP} = 0.467$ ($p < 0.001$)	$R_{SP} = 0.867$ ($p < 0.001$)	$R_{SP} = 0.978$ ($p < 0.001$)
Level of use	$R_{SP} = 0.281$ ($p < 0.001$)	$R_{SP} = -0.323$ ($p < 0.001$)	$R_{SP} = 0.464$ ($p < 0.001$)	$R_{SP} = 0.221$ ($p < 0.001$)	$R_{SP} = 0.637$ ($p < 0.001$)	$R_{SP} = 0.638$ ($p < 0.001$)
Student's background in using online courses	$R_{SP} = -0.263$ ($p < 0.001$)	$R_{SP} = -0.355$ ($p < 0.001$)	$R_{SP} = 0.526$ ($p < 0.001$)	$R_{SP} = 0.682$ ($p < 0.001$)	$R_{SP} = 0.456$ ($p < 0.001$)	$R_{SP} = 0.758$ ($p < 0.001$)
Student's access in SPOC	$R_{SP} = -0.372$ ($p < 0.001$)	$R_{SP} = -0.184$ ($p < 0.001$)	$R_{SP} = 0.967$ ($p < 0.001$)	$R_{SP} = 0.578$ ($p < 0.001$)	$R_{SP} = 0.978$ ($p < 0.001$)	$R_{SP} = 0.886$ ($p < 0.001$)

professional skills, such as instrumental and vocal performance, analyzing and creating music, improvement of knowledge in the field, and project competencies, can be associated due to the established positive correlations with online learning activities based on the signature pedagogy.

The advantages of the implementation of SPOC in music education based on signature pedagogy will be significant in the following aspects:

- Unlimited access to special online resources and teachers' instructions;
- Active exchange of music teacher experience between a wide range of participants, remote discussions, and critical analysis of relevant problems and challenges;
- Close interaction with a teacher for developing personal learning schedules; and
- Comfortable way for student's professional self-improvement through productive training practice.

Limitations

In this research, the study of the effectiveness of online learning based on signature pedagogy for future music teachers was investigated within the educational process of a Russian university. However, similar bachelor's programs are carried out at other universities worldwide. Thus, the comparison of the educational experience between two or more different institutions would bring clarification in this area generally. Moreover, due to the COVID-19 pandemic, remote teaching was widely implemented. We did not include the data from other universities due to the particular aims of this study, which required us to focus on the correlations between the technical tools of online learning and student–teacher satisfaction. This gap could be addressed in future studies.

Future work

Due to the hard frames of the manuscript requirements, the study demonstrated only less part of the assessment tools of the online teaching of music based on signature pedagogy. The design of the evaluation, covering all the aspects and correlations between digital environment features and music skills, needs to be studied more thoroughly. Moreover, the way of implementation of online learning tools in the fields required close human interaction and moral support, such as different types of art and clergy, should be studied more precisely.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Human Ethics Advisory Group of Kazan Federal University by using the ethical guidelines for educational research proposed by the British Educational Research Association [BERA], 2018. The patients/participants provided their written informed consent to participate in this study.

Author contributions

The research is the result of the collaboration of all the authors. However, Sections Introduction, Background, Materials and methods, Discussion, and Conclusion are attributed to SK. Section Results and Conclusion to SK, ED, and IY. Sections Discussion, Conclusion, Limitations, and Future work to JM, RV, and MB. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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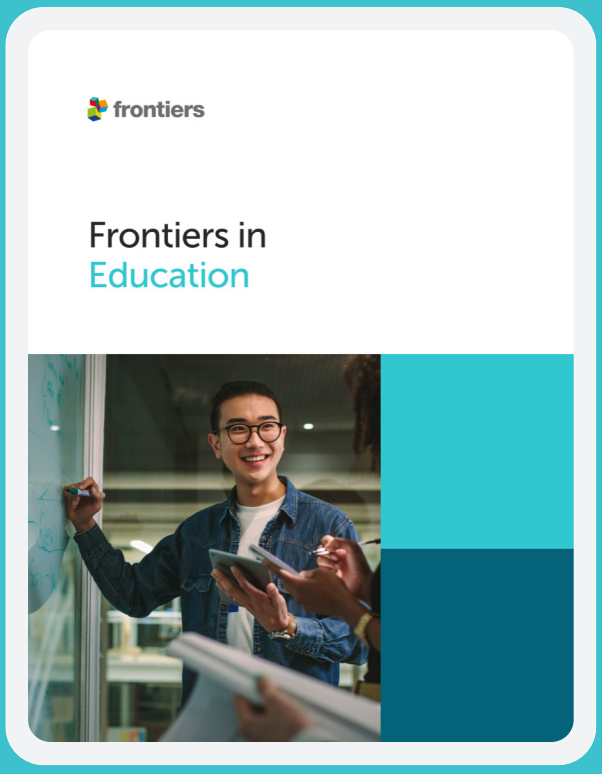

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