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Innovations in teaching and learning: International approaches in developing teacher education and curriculum for the future

Edited by
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Innovations in teaching and learning: International approaches in developing teacher education and curriculum for the future

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Editorial: Innovations in teaching and learning: international approaches in developing teacher education and curriculum for the future

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Editorial on the Research Topic
Innovations in teaching and learning: international approaches in developing teacher education and curriculum for the future

Over the past few years, educators worldwide have confronted a surge of unprecedented challenges in refining their instructional methods. Factors such as population mobility, an unstable labor market, and the rapid pace of globalization, as noted by the United Nations (2020), have contributed to this dynamic shift. Moreover, the education field undergoes continuous transformation, necessitating ongoing adaptations to redefine and enhance learning and teaching environments. Contemporary educational psychology, exemplified by movements like positive psychology, emphasizes aspects such as fostering belonging and collaborative knowledge creation. This calls upon teachers to prioritize facilitating their students' learning and wellbeing, thus creating positive learning environments over traditional teacher-centered approaches (Seligman, 2011; Csikszentmihalyi, 2014; Talvio and Lonka, 2021).

The advent of the digital revolution further challenges educators to embrace new educational paradigms and incorporate digital solutions into their pedagogical strategies. Indeed, the COVID-19 pandemic has accelerated this need, prompting teachers to innovate and provide optimal learning experiences (Lonka and Talvio, 2021). Teachers should be empowered to use their professional knowledge, competences, and expertise to deliver the curriculum successfully. A decisive commitment to teachers' continuous training becomes indispensable, namely through the strengthening of knowledge based on empirical evidence that can focus on a curriculum "adaptable, dynamic and collaborative" (Ferreira, 2023).

The primary objective of this Research Topic was to compile recent studies on pedagogy and educational psychology, focusing on innovations in teaching and learning worldwide. By gathering scientific insights from diverse stakeholders such as curriculum developers, practitioners, and researchers, the aim was to conceptualize, evaluate, and develop creative pedagogical concepts and practices suitable for the diverse contexts of twenty-first-century educational settings. In this Research Topic, we have strong international contribution covering countries in Europe, Asia, and the Middle East.

The Research Topic revolves around three core themes. The first theme focuses on *teacher-student interaction and classroom dynamics*. Martinsone and Žydžiūnaite delved into pivotal factors crucial for cultivating positive school climates and nurturing empathetic relationships with students. Their study aimed to grasp the needs of teachers in educator training, with the goal of equipping them with the requisite knowledge and skills to bolster their students' wellbeing. In their article, Rodríguez-Ferrer et al. investigated the effects of a game-based learning program on classroom environments and student engagement. Their findings provide compelling evidence of the benefits of employing game-based learning in high schools located within socially disadvantaged communities in Spain. Hojeij et al. explored the experiences of Emirati female preservice teachers with virtual classroom management. They underscored the significance of training in virtual learning technologies for both teachers and students to achieve satisfactory learning outcomes. The impact of feedforward on enhancing critical thinking and academic writing skills among pre-service teachers were examined by Baroudi et al.. Their research revealed that this teaching approach not only increased students' motivation to improve their performance in subsequent tasks but also elevated the quality of their work.

The second theme of the Research Topic focuses on *language learning and various teaching methods*. He and Oltra-Massuet examined whether advanced English as a Foreign Language (EFL) learners could reach a level of proficiency similar to that of native English speakers. They utilized the Elicited Oral Imitation Task test to assess learners' grammatical sensitivity and language production abilities in constructing English questions with refined grammatical errors. The study compared the performance of EFL participants with that of native speakers, revealing that advanced EFL students faced challenges in attaining implicit knowledge of English questions at the level of native speakers. Additionally, they observed a disparity between the language knowledge level and language production competence of EFL learners. In another study within this theme, Xu and Wang investigated how EFL student teachers transform their Pedagogical Content Knowledge (PCK) into Personal Practical Knowledge (PPK) within blended learning communities. The research findings shed light on the development of personal practical knowledge among EFL student teachers and its contribution to teacher education research and pedagogy.

The third theme of the Research Topic centers on *educational trends and teacher professional development*. Cao conducted a meta-analysis to assess the effectiveness of blended learning, taking into account factors like student performance and engagement. Their findings showed that while blended learning typically improved performance, attitudes, and achievements, it did not necessarily enhance student engagement in academic activities. Cui and Yin examined the impact of professional training on fostering teaching innovation among senior high school educators. They discuss their findings as a guide for developing more targeted and personalized teacher training programs, emphasizing the importance of autonomy for school administration and peer support in promoting teaching innovation. Lastly, Akcan et al. investigated teachers' perspectives on the implications of STEM education for the job market. Based on in-depth interviews with 32 teachers, they concluded that STEM education offered many benefits to learners, though some concerns were raised. The authors also provide suggestions for the future of STEM education.

Author contributions

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An experimental study on grammatical sensitivity and production competence in Chinese and Spanish EFL learners and its implications on EFL teaching methods

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Implicit knowledge acquired by L2 learners determines their language competence; however, it remains an issue to what extent advanced EFL learners can acquire implicit language knowledge. This study aims at finding out whether advanced EFL learners from two different L1s could acquire a level of implicit knowledge of English questions by using the modified Elicited Oral Imitation Task. A quantitative, experimental study with the Elicited Oral Imitation Task experimental tool was designed. A total number of 91 participants were recruited *via* the online experimental platform from October to November, 2021, distributed into a native speaker group, a Chinese EFL learner group, and a Spanish EFL group. The study evaluated participants' implicit language knowledge by assessing two indicators: the grammatical sensitivity index and the production index. Independent-sample *t*-test and one-way analysis of variance (ANOVA) were applied to examine the differences in the two indices among different groups. Results revealed that both EFL groups displayed a significant difference with the native speaker group in their degree of implicit knowledge of English questions in general. A further comparison of the two indicators showed that while both EFL groups displayed a relatively high grammatical sensitivity to morpho-syntactic errors in English questions, their corrective production rate of ungrammatical sentences was notably lower. These results indicate that advanced EFL learners had difficulty in acquiring implicit knowledge of English questions at native speaker' level. These findings also imply a gap between EFL learners' language knowledge level and corresponding language production competence. Targeting this gap within the Interaction-based production-oriented approach pedagogical implications based on were suggested for enhancing EFL learners' language production competence in EFL contexts.

KEYWORDS

EFL learners, implicit knowledge, grammatical sensitivity, language production competence, interaction-based POA tasks

Introduction

The extent to which second language (L2) learners can acquire implicit knowledge (IK) largely determines their language competence, including comprehension and production (Paradis, 2009), but whether L2 learners can acquire IK has remained a matter of debate (VanPatten et al., 2020). It is not unusual for researchers and practitioners to see that advanced English as a Foreign Language

(EFL) learners who can articulate grammar rules and perform excellently in various written examinations still produce ungrammatical morpho-syntactic structures in sentences that appear to be simple in spontaneous oral communication. This kind of 'what I know' and 'what I can' incongruity aroused our interest to experimentally probe whether EFL learners' language knowledge and language production competence develop simultaneously as that of native speakers. A number of previous studies have investigated L2 learners' implicit language knowledge by testing their grammatical sensitivity (Tokowicz and MacWhinney, 2005; Abrahamsson and Hyltenstam, 2008; Roberts and Siyanova-Chanturia, 2013; Zhang, 2015; Suzuki and DeKeyser, 2017), whereas little research has studied learners' language production, despite its importance in evaluating learners' L2 acquisition (Kowal and Swain, 1994; Grüter et al., 2012; VanPatten and Williams, 2015).

Aiming at finding out whether and to what extent advanced EFL learners can acquire L2 IK, the present study first addresses the issue of IK acquisition by comparing advanced Chinese and Spanish EFL learners' imitated production of English questions with native speakers, with an experiment subsuming a consecutive process of grammatical sensitivity and language production. The second objective of this study is to delve into the language acquisition trajectory for EFL learners. We tackle the development of language knowledge and language production competence through the analysis of the experimental data unveiling learners' grammatical sensitivity and production competence. Finally, building on the experimental findings, the study puts forward a series of pedagogical implications for course designers and class practitioners in EFL contexts, targeting at enhancing learners' language production competence.

The following two research questions are formulated to address the first and second goals, the IK acquisition and the development of grammar knowledge and production competence.

RQ1: Do advanced EFL learners from different L1s acquire native-equivalent IK in English questions?

RQ2: Does advanced EFL learners' language production competence develop simultaneously with their grammatical knowledge of English questions?

Background

Implicit knowledge and its measurements

The concept of implicit knowledge is elusive and has proved difficult to confront against the notion of general knowledge learning. To address this issue, Berry (1987) distinguished two types of IK, the IK that was once explicit and declarative and the IK that arose from implicit learning, which had never been explicit. In the domain of language acquisition, the former kind of IK defined by Berry explains the L2 learning process in EFL learners, while the latter accounts for the First Language (L1) acquisition process in native speakers. In L2 acquisition, Ellis and Roever (2018) defined implicit language knowledge as the knowledge that learners have not consciously noticed but can access in spontaneous language production through automatic processing, even if it cannot be verbalized. Ellis (2005) summarized the key characteristics of IK through seven properties: intuitive awareness, procedural knowledge, systematicity, automatic processing, accessibility in fluency performance, non-verbalizable language rules, and learnability.

Among all the seven characteristics categorized by Ellis (2005), learners' awareness of grammar has been the focus in studies of implicit

language knowledge measurement (Spada et al., 2015; Zhang, 2015; Kim and Nam, 2016; Suzuki and DeKeyser, 2017; Roehr-Brackin, 2020). To measure learners' IK, some studies have tested learners' grammatical awareness in the process of language comprehension using tools such as timed grammatical judgment, word monitoring test, or self-paced reading, *i.a.* (Gutiérrez, 2013; Suzuki, 2015; Suzuki and DeKeyser, 2017). Other research has evaluated learners' grammar awareness in the process of language production employing tools such as elicited imitation or oral narrative (Ellis, 2005; Erlam, 2006; Spada et al., 2015; Zhang, 2015; Suzuki and DeKeyser, 2017). These previous findings laid a sound empirical foundation for further experimental studies on implicit knowledge. However, existing studies, by either collecting data in language comprehension or language production, only took learners' awareness as the indicator for evaluating learners' implicit knowledge, without paying much attention to learners' production, although production is regarded as essential for explaining the language acquisition process (Kowal and Swain, 1994; McDonough and Chaikitmongkol, 2010; Grüter et al., 2012; Guasti et al., 2012; MacDonald, 2013). Considering the role language production plays in language acquisition, the present study aims at focusing on both learners' awareness of grammar (grammar sensitivity) and competence of production (corrective language production) to explore implicit language knowledge taking the acquisition of English questions by EFL learners as empirical target basis. The study will evaluate the level of advanced EFL learners' implicit knowledge through these two perspectives and explore whether advanced EFL learners' competence of production develops simultaneously with their grammar knowledge in English questions.

Grammatical sensitivity

Grammatical sensitivity, according to Sasaki (2012), was defined as learners' ability to identify the grammatical role of certain words or sentence components in given sentence structures. Students with grammatical sensitivity were able to detect relationships between words and their grammatical function in the sentence (Vanpatten et al., 2013). In Sasaki (2012) and Vanpatten et al. (2013), grammatical sensitivity was defined as learners' ability to recognize the grammatical roles of sentence components, but in more recent studies (Tokowicz and MacWhinney, 2005; Abrahamsson and Hyltenstam, 2008; Keating, 2009; Roberts and Siyanova-Chanturia, 2013), grammatical sensitivity refers to the sensitivity degree that learners show to grammatical violations in ungrammatical structures. The event-related brain potentials (ERPs) data from Tokowicz and MacWhinney (2005) suggested that L2 learners across different proficiency levels were implicitly sensitive to grammatical violations. Keating (2009) found that grammatical sensitivity displayed by adult L2 Spanish learners can be a robust predictor of their aptitude to acquire the structure of gender agreement. Abrahamsson and Hyltenstam (2008) suggested that late learners' high grammatical sensitivity indicated their high language proficiency. Roberts and Siyanova-Chanturia (2013) supported that assessing learners' sensitivity to ungrammatical sentence structures in processing comprehension can uncover how that acquired language knowledge is used in real-time language processing.

These studies revealed that sensitivity to grammatical violation is an important indicator in assessing L2 learners' IK acquisition (Suzuki, 2017; Vafaee et al., 2017). The present study adopted the concept of grammatical sensitivity in terms of learners' reactions to grammatical violations to evaluate EFL learners' level of implicit knowledge in

acquiring morpho-syntactic structures of English questions. Therefore, grammatical sensitivity in this study is exclusively defined as the learners' capacity to recognize the grammar components in English questions tacitly and to unconsciously display a delay in reaction to the ungrammatical features in English questions under experiment. The grammatical sensitivity index, referring to the percentage of ungrammatical sentences detected by participants, is used to quantify learners' sensitivity levels.

Language production

Language production, together with language comprehension, constitutes an interwoven process in the development of language competence when language learners receive input and create output. Recent research done by cognitive psycholinguists such as Pickering and Garrod (2007) regarded that language comprehension and production came from the same system, and the production system was used when prediction and imitation were activated to emulate how imitation and comprehension worked. According to Krashen's (1982) monitor theory, accurate and fluent language production is initiated with the acquired system of knowledge. Language production promoted learners' language learning by helping learners become aware of their existing grammar knowledge gap and enhance their awareness of the links between forms, function, and meaning, which played an important role in L2 acquisition (Kowal and Swain, 1994). Language production reveals learners' real-time processing of language structure, which provides important data for analysing learners' persistent difficulty in acquiring specific language structures (Grüter et al., 2012). As an additional indicator for learners' acquisition of linguistic knowledge, L2 learners' production offers an approach to studying the degree of knowledge acquired by L2 learners. However, so far, not much research focusing on production has been done because of the difficulty in designing an appropriate task to measure learners' language competence (VanPatten and Williams, 2015). In particular, it is not feasible to capture language data in natural language to study a specific target structure. The present study conducts a production experiment to overcome the issue raised by Gass and Mackey (2015) that participants may avoid producing the target structures, eliciting participants to generate the structures of interest with stimuli sentences. We specifically defined learners' production as the number of sentences participants produced with given stimuli. In the elicitation process, participants noticed the ungrammatical features and made corresponding grammatical sentences. We use the production index to designate the percentage of participants' corrective production of ungrammatical experimental sentences.

The oral elicited imitation test

The study chose the elicited oral production test to collect data for measuring EFL learners' IK from language production among the three major categories of experimental methods: (1) a battery of tests including timed grammatical judgment, oral elicited imitation test (OEIT), and oral narrative designed by Ellis (2005); (2) a series of reaction time (RT) tests (Suzuki, 2015) covering visual word paradigm, word monitoring test, and self-paced reading; and (3) a set of cognitive neurolinguistic tools comprising eye-tracking (Keating, 2009; Conklin and Pellicer-Sánchez, 2016; Maie and Godfroid, 2022), event-related potentials (ERPs) (Tokowicz and MacWhinney, 2005; Dowens et al., 2011; Martínez de la Hidalga et al., 2021), and functional magnetic resonance imaging (fMRI)

(Xue et al., 2004; Yokoyama et al., 2006). The OEIT has been considered a promising option since in RT tests and cognitive neurolinguistic experiments, participants were tested mainly in comprehension, not involving learner production, which leaves the question of whether there is a gap between learners' sensitivity and production unsolved.

The OEIT originated from elicited imitation (EI) that can be dated back as early as the 1970s. Early researchers, such as Crain and Thornton (1983), had designed elicited production to perform empirical studies of learners' language competence. However, there has been constant questioning over its effectiveness. Vinther (2002) reviewed studies on the application of EI in child language, neuropsychology, and second language research from 1970 to 1994 and suggested that EI was able to test learners' process of language in comprehension and production under the condition that it was applied with careful consideration of variables such as imitation process, the stimulus length and structure, and linguistic contextual support. On the state that stimuli sentence items of target grammatical features are well-designed, EI could test both learners' sensitivity to knowledge in tacit forms as well as learners' competence in production directly. In the present study, we modified the experimental stimuli sentences by fully considering variables such as sentence length, structure, and contextual support to ensure effective measurement of learners' grammar sensitivity as well as their production.

The OEIT caters best to the research goals of the present study in the sense that it incorporates experimental procedures testing participants' tacit grammatical judgment and direct corrective production. With OEIT experimental data, the authors are able to dissociate participants' performance into grammatical sensitivity and language production indexes. Moreover, the OEIT has been regarded as an effective tool for measuring learners' IK, with its measuring power for language learners' knowledge having been replicated and validated in previous research (Bowles, 2011; Spada et al., 2015; Zhang, 2015; Kim and Nam, 2016). In contrast to earlier studies employing OEIT, the current study intends to go beyond validating and replicating the findings. We adopt the OEIT test tool in this study to collect data from participants' production, intending to investigate the participants' performance from the perspectives of both grammatical sensitivity and production competence.

As reviewed in this section, grammatical sensitivity and language production are two crucial indices for studying implicit knowledge, and OEIT can actually test both. Existing studies on implicit knowledge have mainly focused on analysing grammatical sensitivity, without paying much attention to the production index. In fact, previous OEIT studies have not focused on the production index, either. However, OEIT tasks tacitly tested participants' sensitivity to grammatical violation and consecutively tested the production of experimental sentences, thus offering the possibility to study both sensitivity and production. In contrast to previous research, the present study analyses implicit knowledge acquired by EFL learners from the perspectives of both grammatical sensitivity and production competence and further investigates the development of grammar knowledge and production competence of participants.

Methodology

Research design

A quantitative study with the OEIT experimental tool is designed to reveal EFL learners' degree of implicit knowledge and explore the relationship between the acquisition of language knowledge and language competence.

Participants

The sample size is based on related studies in SLA (Ellis, 2005; Suzuki and Dekeyser, 2015; Suzuki and DeKeyser, 2017). All participants were recruited with simple random sampling *via* the experiment participants' recruitment platform https://www.prolific.co/, which directs participants straight to the experiment platform.[1] The study recruited a total number of 91 participants, but only received valid data from 84 participants, comprising monolingual English native speakers ($n = 12$), Chinese ($n = 35$), and Spanish ($n = 37$) learners of English, after removing those who did not correct any grammatical sentences or provided less than 75% correct answers to comprehension judgments. All native speaker participants are monolingual English speakers, with an education level of undergraduate or above. All EFL participants are advanced learners with an English proficiency level at or equivalent to the C1 level following the CEFR (*The Common European Framework of Reference for Languages*). We further qualified all participants by adding a short C1-level test, filtering out those who could not give three correct answers to five questions. The short C1-level test comes directly from the official Cambridge English test paper, so the test content is reliable for testing participants language proficiency. Before the experiment, we conducted a pilot test with the short C1-level with 8 EFL learners for validation. By comparing their test results with their reported C1-level scores, we got a Spearman correlation coefficient of 0.761 ($p = 0.028$), showing that the short C1-level test has high validity. Participants from both EFL groups are equivalent in their age, education, and starting time of English learning, guaranteeing an effective comparison of the experimental data. Participants were aged from 18 to 40, most of whom were in the age range 21–40 years old. Over 90% of participants were undergraduates or graduates, and most of them started to learn English in primary or secondary school (Supplementary Material shows detailed demographic information of participants).

Experimental tool

Aimed at testing participants' grammatical sensitivity and corresponding production ability, we created a modified experimental tool based on the OEIT (Ellis, 2005). The test in the present study adopted essential criteria for operationalizing constructs from Ellis (2005): intuitive, time–pressure, meaning-focused, and consistent responses without relying on explicit grammatical rules.

The OEIT was updated and revised in the following aspects. First, we added pictures to test participants' understanding of the content of experiment sentences. Linguistic structures tested in OEIT in previous studies were mainly statements, allowing participants to make immediate True/False judgments right after listening to sentence prompts without extra incentives. But in this study, all experimental sentences are questions, with equal amount of grammatical and ungrammatical statements included as fillers to disguise our experimental aim on questions. It is thus impossible for participants to make meaning-focused True/False judgments directly. We presented pictures on the screen simultaneously with the recording to test participants' comprehension of experimental sentences. Second, two improvements discussed in previous validation research (Spada et al.,

2015; Kim and Nam, 2016) were also incorporated into the present test. Since truth-value judgment (used in Spada et al., 2015) is based on the content of the given sentences and is more objective than the belief statement, the current test chose to use truth-value judgments to ensure that learners have processed the sentence stimuli for meaning. True/False judgment was designed in choice (A/B) to test participants' understanding of the content; furthermore, a time limit was added to the test, which allowed participants 20% more time than native speakers (used in Kim and Nam, 2017).

After we designed the initial experimental sentence items, two native speakers were invited to check the naturalness, understandability, and grammaticality of each grammatical item to confirm the face validity of the items. Based on their feedback, we revised all points they provided with correction feedback. Furthermore, to testify the experimental validity and responsibility of the modified OEIT, we conducted a pilot study with 8 native speakers. The results of the pilot study showed a 100% response rate, with an averaged accuracy of 96.9% in grammatical sensitivity, and 96.6% in production competence, suggesting that this modified OEIT effectively measured the level of implicit knowledge.

Experimental procedures

The experiment was approved by the Research-Innovation Ethics Committee from Universitat Rovira i Virgili, Tarragona, Spain. The whole experiment was conducted in the online platform www.Gorilla.sc. After participants read the experimental instruction and ticked the consent form, they filled out a questionnaire about their language learning background. Participants were automatically directed to the experiment page after passing a short proficiency test. The instructions were displayed on the screen with words, pictures, and audios. They informed participants that they might hear a grammatical or an ungrammatical sentence. While the audio (the stimulus) was played, participants had to press a key as a response when they heard the target word that was displayed on the screen. The target word was presented simultaneously to the entire duration time of the audio stimulus. Participants needed to respond quickly by pressing the key before the experimental webpage automatically switched to the next screen. Participants' RT for measuring sensitivity was automatically recorded by the online experimental platform when the key was pressed. To further confirm the authenticity of the RT, pictures (including one picture that revealed the situation/content and one unrelated picture) were used to check whether participants understood the meaning of the stimuli sentences. They needed to choose the picture that matched the content of each sentence. Next, participants were guided to repeat the sentences orally using correct English, and their productions were audio recorded. After the instruction, they completed five practical trials and could choose to re-practice if necessary. All their comprehension answers and their utterances were recorded as experimental data. The experimental procedure is shown in Figure 1.

Scoring

Before scoring, filler sentences and invalid experimental sentences with incorrect comprehension judgments were eliminated, and we only kept the critical experimental sentences with correct comprehension judgments. The scoring criterion was based on obligatory occasions (Dulay and Burt, 1973). In this case, only matched question structures produced by participants were included in the analysis because
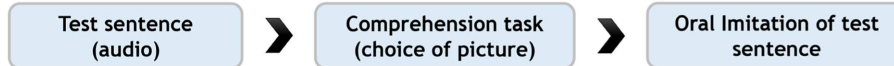

1　www.Gorilla.sc

FIGURE 1
Experimental procedures of Elicited Oral Imitation Task.

participants needed to form the same type of question structure as what they heard in the audio. Each participant's grammatical sensitivity and production accuracy score was marked separately. One score was given for a correct response and zero for an incorrect one, with a total score ranging from 0 to 40. A higher score indicated a higher sensitivity or production accuracy. The scoring was independently done by one researcher and a research assistant, and the score of each item was double checked. Any disagreement in scores was solved after discussion. The scoring criteria in terms of sensitivity and production score for ungrammatical and grammatical experimental items are specified in Supplementary Material.

Statistical analysis

Descriptive statistics, including frequency and constituent ratio, were used to describe participants' demographic characteristics and the overall performance of each group in grammatical sensitivity and language production. The Kolmogorov–Smirnov test suggested that the grammatical sensitivity and language production were not normally distributed; however, we selected parametric tests for data analysis due to the following two reasons: (1) the Kolmogorov–Smirnov test results flux and are not always reliable as the sample size varies, especially with a big sample size (Steinskog et al., 2007); and (2) normal distribution of these two indicators was assumed in the present study based on the Histogram, the Normal Q-Q Plot, and values of skewness and kurtosis (Ho and Yu, 2015). Therefore, we summarized grammatical sensitivity and language production using mean and standard error (SE). Meanwhile, independent-sample t-test and one-way analysis of variance (ANOVA) were applied to examine the difference in grammatical sensitivity and language production among different groups. When a statistically significant result was detected for the overall test using ANOVA, a post-hoc test was performed using Fisher's Least Significant Difference (LSD) to investigate which group differed from the others in terms of grammatical sensitivity and language production. All statistical analyses were performed by using IBM Statistical Package for Social Sciences (SPSS) version 22.0 (SPSS Inc., Chicago, United States). A two-tailed $p < 0.05$ indicated statistical significance.

Results

Descriptive data

The participants produced 3,360 valid utterances. Among these sentences, 480 were from native speakers, 1,480 were from Spanish EFL learners, and 1,400 were from Chinese EFL learners. Native speakers showed grammatical sensitivity in 470 sentences (97.9%) and produced 468 sentences correctly (97.5%), indicating they are extremely sensitive to grammatical errors and highly proficient in correcting grammatical errors automatically. In comparison to the Spanish group, which produced 1,295 (87.5%) and 1,224 (82.7%) correct sentences out of 1,480 total, the Chinese

EFL group demonstrated grammatical sensitivity at 1186 (about 84.7%) and produced 1,102 (78.7%) correct sentences.

The results showed that EFL learners developed a high sensitivity to ungrammatical structures, but their production lagged. To explore the relationship between sensitivity and production competence, we looked into the data of the native speaker group and the two EFL learner groups. We observed that native speakers corrected about 99.5% (468 out of 470) of ungrammatical sentences to which they showed grammatical sensitivity, i.e., they produced almost all ungrammatical sentences in correct forms. The results indicated a high degree of IK in their native language. For Chinese and Spanish learners, they successfully corrected 92.9% (1,102 out of 1,186) and 94.5% (1,224 out of 1,295) of the sentences where they detected grammatical errors (Table 1). The results revealed that advanced EFL learners could correct most ungrammatical errors they recognized, but their correction rates were much lower.

Results of between-group difference in sensitivity and production

Results of ANOVA indicated a significant difference in the overall score of sensitivity ($F = 9.59$, $p = 0.000$) and production ($F = 13.69$, $p = 0.000$) among the three groups. Furthermore, the LSD post-hoc multiple comparison tests showed that the mean sensitivity and production scores for the native group were, respectively, 39.2 and 39 out of 40 in total, significantly higher than the Chinese group with a large effect size for sensitivity (MD = 5.28, SE = 1.21, $p < 0.001$, Cohen's $d = 0.822$) and a medium effect size for production (MD = 7.51, SE = 1.44, $p < 0.001$, Cohen's $d = 0.691$), and the Spanish group with a large effect size for sensitivity (MD = 4.12, SE = 1.20, $p = 0.001$, Cohen's $d = 0.637$) and with a large effect size for production (MD = 5.92, SE = 1.43, $p < 0.001$, Cohen's $d = 0.535$). However, the difference in sensitivity and production between the two EFL groups was not significant, with a small effect size (MD = −1.11, SE = 0.85, $p = 0.195$, Cohen's $d = 0.219$) for sensitivity and a small effect size (MD = −1.60, SE = 1.015, $p = 0.120$, Cohen's $d = 0.183$) for production (see Table 2). Even though the two advanced EFL groups were highly sensitive to ungrammatical structures and were able to produce grammatical sentences with an accuracy rate of about 80%, they were at significantly lower level of sensitivity and production compared to native speakers.

Results of within-group of sensitivity and production

We analysed participants' sensitivity and production scores in order to further examine whether there was a notable gap between participants' grammatical knowledge and production competence. The results showed no significant difference with a medium effect size ($t = 1.483$, $p = 0.166$, Cohen's $d = 0.605$) in the NS group, but a significant difference in the Chinese with a large effect size ($t = 7.364$, $p < 0.001$, Cohen's $d = 1.760$) and Spanish group with a large effect size ($t = 8.703$, $p < 0.001$, Cohen's $d = 2.023$) (see Figure 2). The

results demonstrated that native speakers possessed a high degree of implicit language knowledge that enabled them to produce correct sentences automatically. However, the results from Chinese and Spanish EFL learners revealed that, even at an advanced level, there was a notable difference between their language knowledge and language production competence.

Discussion

The present study first shows that Spanish and Chinese advanced EFL learners have hardly acquired native speakers' IK of English questions. The results also reveal that advanced EFL learners' language production competence falls behind their language knowledge acquisition. This section will discuss EFL learners' acquisition of English questions by analysing learners' IK level and the development of language production competence from the perspectives of grammatical sensitivity and language production.

Implicit knowledge of native speakers and advanced EFL learners

The results of both between-group and within-group comparisons answered the first research question. First, the native and EFL between-group comparisons showed that both Spanish and Chinese EFL learners' sensitivity and production scores are significantly lower than Native speakers (as shown in Table 2), which suggests that EFL learners do not possess the same IK as native speakers. Therefore, we may conclude that it is difficult for EFL learners to acquire IK, even at an advanced proficiency level. As elaborated in the previous section, language learners who acquire IK are supposed to be highly sensitive to morpho-syntactic errors and capable of producing grammatical language with a high accuracy rate.

Another difference between EFL learners and native speakers comes from the comparison of their capacity for correcting morpho-syntactic errors to which they showed sensitivity. From the Production-Sensitivity data in Table 1, we can see that native speakers correct almost every error they detect, while the Chinese group and the Spanish group show a relatively lower correction rate. We assume that IK refers to an equivalency between sensitivity and production. Native speakers can make grammatical sentences automatically because their IK enables them to produce them as soon as they subconsciously recognize ungrammatical features. Therefore, for learners who have acquired IK, there should not be a significant gap between their grammatical sensitivity and production competence. However, the sensitivity-production gap reflected in both Chinese and Spanish groups is significant (shown in Figure 2), which suggests that the grammatical knowledge they acquired is not implicit. They did not show equivalent automatic correction to morpho-syntactic errors they recognized. These findings allow us to conclude that advanced EFL learners may have acquired some L2 IK but not IK *per se* of the native speakers.

Moreover, the native speaker group shows high consistency between their grammatical sensitivity and production, because their implicit L1 knowledge enables them to produce correct sentences as soon as they tacitly recognize the grammatical violation. It is sensible for us to propose that the consistency in the native group and inconsistency in the EFL groups stem from the difference in their degree of implicit language knowledge. As discussed above, native speakers could spontaneously produce norm-conforming language without relying on conscious grammar knowledge (Ellis and Roever, 2018). Native speakers' L1 acquisition depends mainly on the IK they acquired *via* implicit learning, while EFL learners' L2 acquisition generally comes from explicit and implicit knowledge through both explicit and implicit learning (Hulstijn, 2005). Native speakers and EFL learners acquire the language in distinct contexts and processes, which causes differences in the knowledge they acquire. We can surmise that advanced EFL learners' differences in sensitivity and production stem from their lack of IK on par with their native counterparts.

Grammatical sensitivity vs. production competence

Grammatical sensitivity reflects learners' degree of acquired language knowledge, which subsequently influences their production competence (Vanpatten et al., 2013). Therefore, in this study, we studied advanced EFL learners' grammatical knowledge level and language production competence to answer the second research question. We found that both

TABLE 1 Effective responses in grammatical sensitivity and production.

	Sensitivity N (%)	Production N (%)	Production-Sensitivity N (%)
NS group	470 (97.9%)	468 (97.5%)	468 of 470 (99.5%)
CH group	1,186 (84.7%)	1,102 (78.7%)	1,102 out of 1,186 (92.9%)
SP group	1,295 (87.5%)	1,224 (82.7%)	1,224 out of 1,295 (94.5%)

NS, native speaker; CH, Chinese speaker; SP, Spanish speaker.

TABLE 2 Results of between-group multiple comparisons with LSD test.

Test type	Comparison	MD	SE	Value of *p*	95% CI	
					Lower limit	Upper limit
Sensitivity	NS vs. CH	5.2809	1.20854	0.000	2.8763	7.6856
	NS vs. SP	4.1666	1.20018	0.001	1.7787	6.5546
	CH vs. SP	−1.1142	0.85186	0.195	−2.8092	0.5807
Production	NS vs. CH	7.5142	1.43931	0.000	4.6505	10.3781
	NS vs. SP	5.9189	1.42935	0.000	3.0750	8.7629
	CH vs. SP	−1.5953	1.01452	0.120	−3.6139	0.4232

NS, native speaker; CH, Chinese speaker; SP, Spanish speaker; MD, mean difference; SE, standard error; CI, confidence interval.
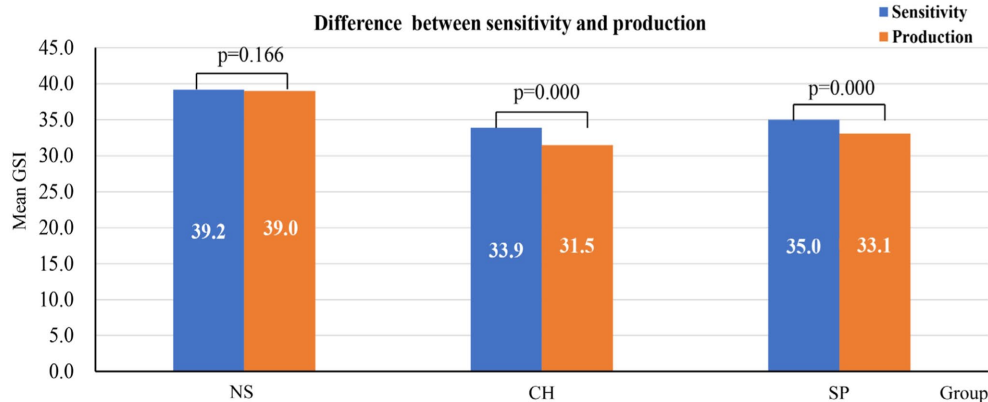
FIGURE 2
Paired *t*-test of difference between sensitivity and production. NS, native speaker; CH, Chinese speaker; SP, Spanish speaker.

Chinese and Spanish EFL learners show more robust competence in language sensitivity than in production, so we suggest that this inequivalence indicates that (1) advanced EFL learners' grammatical knowledge develops prior to their production, and thus their acquisition process in EFL contexts tends to be more explicit, and that (2) advanced EFL learners still confront difficulty in accuracy when they are outputting language in a time-pressed automatic production.

Previous research studying learners of various L2 also showed that language learners faced difficulty in attaining production competence regarding some grammatical features, despite an advanced language proficiency level. Grüter et al. (2012) found that high-proficiency L2 Spanish learners showed difficulty in gender marking for nouns with real-time processing in an elicited production task. Siyanova and Schmitt (2008) reported that advanced Russian learners of English could not automatically produce English collocations with the same fluency as native speakers.

Our result that Chinese and Spanish EFL learners' grammatical sensitivity significantly exceeded their production competence was also supported by a few previous studies on language perception and production. Linebaugh and Roche (2015) found that L2 learners' accurate production is generally preceded by their L2 perception, even though production may enhance learners' perception. Ahmadian (2012) supported L2 English learners of lower, intermediate, and even advanced proficiency showed problems producing accurate English articles, although they learned the grammar knowledge of articles well. The findings of the present study further confirm that EFL learners confront problems building some structures even though they are familiar with related grammar knowledge. Our study contributes additional evidence showing that advanced EFL learners' language competence of production does not develop simultaneously with their grammatical knowledge. Targeting the problem of the unbalanced development of EFL learners' language knowledge and language production competence, the following section will offer pedagogical implications for practitioners to improve learners' production competence in the EFL contexts.

Pedagogical implication

Implicit knowledge fostering EFL context

A primary concern for improving learners' production competence is to promote EFL learners' degree of IK, which, to be specific, lies in how to encourage the simultaneous development of learners' language knowledge and production competence. It is closely related to how to convert the 'monitoring' function of grammar knowledge into the 'driving' power from subconscious grammar sensitivity. The conversion process highly conforms to the first type of IK in the seminal definition by Berry (1987), namely, the IK that was once explicit and declarative but gradually evolved into subconscious IK. Berry (1987) described a classical three-stage model of the IK formation process comprising a cognitive stage, an associative stage, and an autonomous stage (as shown in Figure 3). According to Berry's (1987) model, implicit knowledge develops in three stages: the cognitive stage, where instruction or observation aids in knowledge acquisition; the associative stage, where practice helps to transform knowledge acquired in the previous stage into production; and the autonomous stage, where practice allows learners to process knowledge to the degree that they unconsciously produce what they have learned, at which point it becomes procedural or implicit. To gauge our EFL participants' performance, we found that learners showed grammatical sensitivity but could not produce certain grammatical structures correctly. This suggests that in their learning process, learners were still in the cognitive stage and had only learned some grammatical rules of the structure, and they had not yet reached the associative and autonomous stages. To 'implicitize' the knowledge from its declarative and explicit predecessor, it is crucial to assist language learners in moving from the cognitive stage to the associative stage, where they can use the language structures in correct forms. And it is important to foster learners' IK acquisition when moving from the associative stage to the autonomous stage in which they can produce language 'without thinking'. From Figure 3, we can see that in the two transitions of the in-between stage, a key word 'practice' is mentioned. To put it in the domain of L2 acquisition, 'practice' does not mean, in no way, to do mechanical drills and repetitions to promote learners' acquisition of IK. Instead, we consider that it will be effective if 'practice' is conducted in production-oriented learning activities based on meaningful interactions in communicative episodes.

Production-oriented and interaction-based EFL pedagogical principles

In EFL environments, classroom-based language teaching and learning contexts are prevailing. Therefore, pedagogical concepts must

FIGURE 3
Berry (1987)'s three-stage model of IK acquisition.
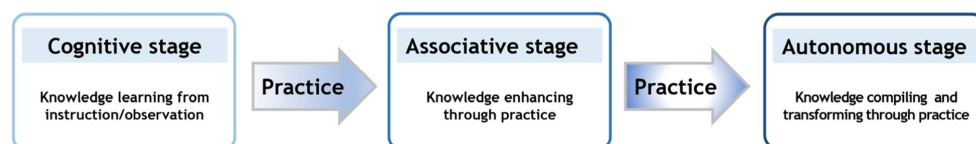
assist teaching designers or practitioners to "foster acquisition-rich interaction" (Ellis, 2017). To reduce the discrepancy between grammar knowledge and language production identified in our study among EFL learners, we propose constructing language class activities that are production-oriented (Wen, 2018) and interaction-based (Ellis, 2017; Oliver et al., 2017; Adams and Oliver, 2019). The following subsections provide more details on the concepts we put forward.

Production-oriented approach tasks

In EFL contexts, one of the most prominent challenges teachers and learners must face is the lack of natural communicative contexts for learners to practice the L2. We suggest that creating communicative contexts in the teaching process focusing on output be conducive for learners to produce an L2. Meanwhile, how to encourage learners' willingness to produce the target language structures is also a pedagogical concern that practitioners need to consider. Wen's (2018) *Production-oriented Approach* (POA) tasks offer teaching guidelines to solve the problem of insufficient communication and production in EFL contexts. In POA, the first stage, namely the motivating stage, aims at getting learners prepared to participate in activities and notice their gaps in knowledge and competence (He and Oltra-Massuet, 2021). Language learners are encouraged to recognize their own deficiencies in language knowledge. During this process, they may resort to their explicit language knowledge, which serves as the basis for their subsequent production. In the second stage of POA, enabling stage, learners are provided contexts for them to conduct specific mini-production tasks in close-to-life communicative scenarios. The target structures are used in communicative activities when they are working on completing their production tasks. Therefore, their explicit knowledge is covertly or explicitly practiced, which helps to enhance their comprehension of knowledge and automaticity of production. The final assessing stage includes teacher feedback, peer feedback, and learners' self-evaluation on learners' production, which consolidates learners' knowledge and confirms their achievement in language production.

Interaction-based production-oriented approach tasks

Interaction should be taken into full consideration in POA tasks, as interaction fosters EFL learners' implicit learning of target language structures. Interaction promotes learners' L2 acquisition in that interactive activities, such as implicit and explicit multi-source feedback, provide learners with opportunities to recognize problems in their interlanguage and propel them to produce modified output (VanPatten and Williams, 2015). In reviewing POA, Ellis (2017) also suggested that the inclusion of

interactive activities into POA facilitates learners' acquisition of target language structures. Therefore, interactive activities should be incorporated into designing the whole production-oriented tasks.

According to Gass and Mackey (2015), three main components of the interaction approach that account for the learning process are exposure to the target language, production of the language, and feedback on the production, which links learners' language acquisition with the cognitive mechanisms of noticing, working memory, attention, and automation. These essential concepts are represented in interactive activities such as elaboration, recasting, repetition, or feedback. Merging these interactive activities into the three-stage procedures of each POA mini-task boosts its interactive function and facilitates learners' language acquisition.

As shown in Figure 4, the psychological mechanism that includes noticing, working memory, and attention links interaction and language learning, which is at the core of the Interaction-based POA tasks. These core concepts are then realized in mini tasks designed for the three POA stages for promoting learners' language production in communication. Finally, interactive activities such as exposure to language, production of the language, and feedback on the production are carried out throughout the three POA stages. The whole Interaction-based POA tasks can be cycled throughout the whole learning process until learners automatically produce the target language, stimulating them to acquire target structures with communicative motives in the simulated scenarios. The cycling process explains Berry's (1987) key element of 'practice' in an interactive way rather than using mechanical drills in forming the IK. The entire interaction process loaded on POA tasks pushes language learners to advance from the cognitive stage to the associative stage and finally reach the autonomous stage, facilitating their acquisition of IK.

Conclusion

In the present study, we adopted the OEIT test to measure learners' grammatical sensitivity and language production competence on English questions with refined grammatical errors. Chinese and Spanish EFL participants' performance was analysed compared to native speakers, to probe the degree of implicit language knowledge acquired by EFL learners from two different L1s. The OEIT data was dissociated to study their grammatical sensitivity and production competence, revealing their development trajectory of language production competence. In sum, this study showed that: (1) both Chinese and Spanish EFL learners face great difficulty in acquiring IK of English questions, despite having attained an advanced proficiency level; (2) Chinese and Spanish EFL learners' grammar knowledge and production competence do not develop simultaneously, and their production competence falls behind their level of grammar knowledge. Our results also support previous studies (Siyanova and Schmitt, 2008; Ahmadian, 2012; Grüter et al., 2012; Linebaugh and Roche, 2015) showing that even

FIGURE 4
Interaction-based POA tasks.
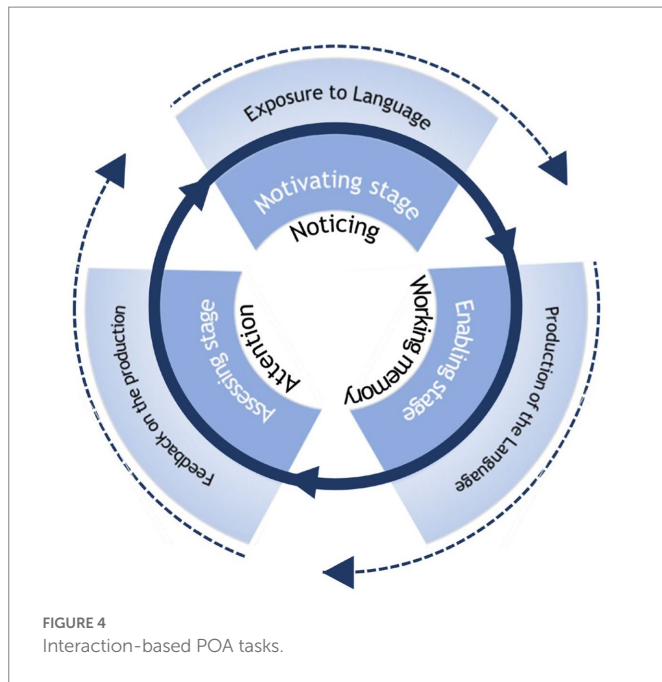
advanced language learners still confront difficulty in acquiring high production competence in certain grammatical features. The findings answered the question raised in He and Oltra-Massuet (2021) that certain types of errors, such as choice of auxiliaries (their GAUXC), produced by preliminary learners in English question formation, persist in the production from advanced EFL learners.

Based on the findings of this study, pedagogical implications have been formulated following Berry's (1987) three-stage model of developing IK that derives from explicit and declarative knowledge, developed within Wen's (2018) POA. We suggest that Interaction-based POA tasks assist EFL learners in attaining balanced development of their language knowledge and production competence, promoting their IK acquisition.

However, the present study is not without limitations. First, although our sample size is based on similar sizes in related studies, larger and more extensive participants would be preferable for more reliable results in future studies. Second, the present study focused only on implicit knowledge measurement, including experiments for directly testing participants' grammatical knowledge would add additional support for exploring the development of language knowledge and production competence.

More research is needed along both theoretical and practical inquiries to support the findings of the present study. First, a series of experiments, including written tests, explicit language knowledge measurements, and IK measurements, need to be performed to explore the evolving mechanism of EFL learners' language competence development. Second, action research based on the pedagogical implications discussed above needs to be conducted to trace the practical value of the findings achieved in this study so as to generate more theoretical and practical contributions to the language teaching and research field.

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 Institutional Review Board of Universitat Rovira i Virgili (Approval code: CEIPSA-2021-TD-0002). The patients/participants provided their written informed consent to participate in this study.

Author contributions

QH conceptualized the topic, designed and conducted the experiment, analyzed the data and wrote the manuscript. IO-M conceptualized the topic, instructed the experiment, and reviewed and proof-read 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

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1096875/full#supplementary-material

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Using feedforward to improve pre-service teachers' academic writing and critical thinking skills

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Introduction: Literature to date indicates that constructive, timely, and personalized instructor feedback to student work boosts their academic performance. Peer feedback has been investigated extensively for the past three decades and has demonstrated its effectiveness where students were trained to give quality feedback. Little, however, is known about the use of feedforward as a strategy that focuses on future assignments and paves the way to improved performance.

Methods: This study followed an action research design using a mixed-method approach to examine the impact of feedforward on developing pre-service teachers' performance on two main skills: critical thinking and academic writing. The teacher researcher followed the same cohort of 14 Emirati pre-service teachers' over two semesters and used a pre- and post-test to collect quantitative data and a survey to collect qualitative data. Findings in this research study reveal that when using feedforwarding on the same cohort of 14 pre-service teachers over the period of two academic semesters, their scores on the post-test for the two skills improved.

Results: This new strategy promoted their motivation to improve their performance on the next task and enhanced the quality of their work. Findings also highlight potential reasons that inhibited the participants' ability to create rich assignments that include content-specific vocabulary and to make connections with the course content.

Discussion: This study implies for curriculum designers at the K-12 level to integrate authentic tasks that engage students with real-world problems and train them on inferring information as a scaffold to the development of their critical thinking skills.

KEYWORDS

feedforward, English as Foreign Language, pre-service teachers, action research, critical thinking

Introduction

Feedback is considered an integral part of formative assessment as it helps both teachers and students understand their progress in their courses. Feedback is essential for teachers as it helps them identify the skills students need to know, their current status, and the targets they need to reach (Brookhart, 2017). While feedback requires interaction with students, the existing literature indicates that most of the time, the occurrences of interaction during feedback are very minimal; feedback is still viewed as a mono-directional response from teacher to student (Merry et al., 2013). This drawback is what directed educators to develop the concept of feedforward.

Although feedback and feedforward both help in the process of student learning and student progress (Higgins et al., 2001; Gavaldon, 2019), feedforward is intended to pave the way for improved performance in future assignments (Koen et al., 2012). The purpose of this type of

response is to help students avoid making mistakes in the first place, even before starting the new assessment. The benefits of this approach can be extended to other assignments as well. Many studies were conducted to investigate the effect of feedforward on student performance. For example, the analysis of a study conducted by Selvaraj et al. (2021) authenticated that teachers' feedforward as a form of feedback practice is pertinent in assuring that students are informed of their academic development.

In the context of higher education, using the strategy of feedforward is mostly for the purpose of minimizing failure by supporting students who might face many challenges that negatively impact their performance. A study conducted by Saeed and Mohamedali (2022) suggests that feedforward approaches allow students to increase their overall effort when attempting summative assessments and, thus, improve their performance, engagement, and retention. Specifically, when using this strategy with the pre-service teachers, it helped them not only to know how they were doing now but also equipped them with the necessary means to make progress in their academic writing and critical thinking skills. Critical thinking and despite being a skill needed to prepare students for future job demands, is hardly being taught in higher education mainly due to difficulties in implementing it in classrooms (Abasaid and Ferreira, 2022).

In the teaching preparation programs, Emirati pre-service teachers reported finding their teaching preparation programs difficult as they sensed a gap between their knowledge and the level of knowledge required, especially that the courses were delivered in English and required high levels of critical thinking and reflective skills (Hojeij and Baroudi, 2018). Furthermore, these pre-service teachers were expected to deliver high quality assignments written with specific academic writing standards which they were not used to at the K-12 level. These standards include using content-specific language, understanding of developmentally appropriate information about learner needs and differences, reflecting deeply, using constructive discussion of observed events, and being proficient in a wide range of content-specific vocabulary contributing to meaningful communication. To that end feedforward as a form of feedback was used as an intervention in this current study with a cohort of 14 Emirati female pre-service teachers at one teaching preparation program at a university in the United Arab Emirates (UAE). This study aims to answer the following questions:

(1) What is the effect of feedforward on pre-service teachers' critical thinking skills?
(2) What is the effect of feedforward on pre-service teachers' academic writing skills?

Literature review

Feedforward as a student-centered teaching strategy

The concept of formative feedback is based on the socio-cognitive perspective of learning and specifically on the notion of the Zone of Proximal Development (ZPD) created by Vygotsky (Vygotsky and Cole, 1978). This zone determines the difference or distance that exists between what a person can do or develop individually and what he/she can achieve with the help of another. Building bridges between the learner and an expert adult or another experienced person involved in the learning process facilitates this development (Price et al., 2010). If teacher feedback is grounded in positive and constructive comments which help the students restructure their ideas, if it is given soon after the learning event which is receiving feedback, and if the student perceives it as individualized, it can support to improve their learning in some ways, such as helping them see their strengths and weaknesses and it can also guide them toward critical thinking (Gavaldon, 2019). As such, engaging students in the feedback provided by the teacher would enhance its' quality (Carless and Winstone, 2023) and give a sense of gratification which will increase students' intrinsic motivation toward the task performed (Ryan and Deci, 2000).

Feedback is usually given through different mediums; however, students sometimes fail to engage with the feedback provided by their teachers, especially through traditional channels (Higgins et al., 2001). Feedback, in this case, is not looked at as an ongoing process of learning; it is often regarded as a task that is specific to a certain assessment. Literature about feedback -a student-centered strategy- is controversial as generally students felt no benefits associated with feedback if given after they received their grades and if the teacher's comments were generic in nature (Wolstencroft and De Main, 2021). To that end, Carless and Winstone (2023) suggested for teachers to improve their feedback literacy to create a partnership and shared responsibilities and goals with their students. In other words, teachers must always seek to listen to students' struggles with the feedback and students must always share their successes and challenges when using feedback information (Carless and Winstone, 2023).

On another note, students thought about their feedback as a loop that needs closing through the process of feedforward (Reimann et al., 2019). Hence, the importance and value of feedforward as it focuses on future rather than on past experiences (Koen et al., 2012). Feedforward should complement the formative feedback process through which students may know and understand the goals they must achieve (Duncan, 2007). In the UAE, however, findings of a study done by Myers and Buchanan (2022) revealed that a majority of students who engaged with the feedback as feedforward achieved better results, and this reinforced the students' engagement with the feedback given and led to greater take up in future assignments, thereby ameliorating their understanding of the feedforward process and its value for them.

Feedforward is considered as a student-centered tool as it engages students in their assignments and promotes problem-based learning (Moallem and Webb, 2016). However, there were challenges in the actual implementation of the approach itself. Evans (2013) explains how the demands on the lecturer to support student access to and engagement in feedback exchanges are vast and require accurate diagnosis of academic and social needs, empathy with and understanding of the student perspective, and possession of the commensurate skills to employ appropriate scaffolding tools. By developing a dialog about learning through feedforward, concurrent and feedback evaluation, instructors are able to make real-time adjustments to their teaching and respond flexibly and quickly to the challenges of student needs (Cathcart et al., 2014). In order for educators to implement learner-focused evaluation cycles, they need to develop confidence in gathering and responding to feedback, flexibility in their approach to curriculum design, openness in their

discussions with learners, and belief in education as a co-operative enterprise (Cathcart et al., 2014).

Impact of feedforward on students' academic writing skills

Carter et al. (2018) used feedforward as a strategy to give meaningful feedback to a big cohort of nursing students by using exemplars to improve their academic writing skills. The authors concluded that there were different approaches to using the exemplars by the students and that they valued those exemplars and considered them a useful teaching tool. However, these benefits did not always manifest themselves in the students' results. Other studies emphasized the value of using feedforward in enhancing the students' academic writing skills, e.g., (Deyi, 2011; Jones, 2011; Ghazal et al., 2018; Schillings et al., 2018). Although several feedback practices rely on oral or written feedback, according to Quinn (2022) even videos can be used to give feedforward to help the students improve their writing skills. In the study, Quinn (2022) mentioned that the students valued the use of examples in their feedback videos; others reported immediate improvement to their writing grades after viewing one or more videos. Therefore, it is obvious that using videos as a tool of providing feedforward helps to integrate into the feedback practice. Yu and Liu (2021) introduced an evidence-based framework to offer feedforward for students to improve their academic writing skills. This framework is based on the scaffolding teachers and peers provide to students across the technical, social-interactive and individual levels. It displays the vital knowledge students need to understand and use feedback to enhance their academic writing.

Students in general need academic writing skills, an essential means of communication, to be at a certain level (Sultan, 2013). Literature provided evidence on the use of several techniques that would boost students' academic writing skills. These techniques include 1- the use of exemplars or worked examples (Yucel et al., 2014; Carless and Chan, 2017), 2- the use of assessment criteria (Elander et al., 2006), 3- the implementation of training or instruction (Taras, 2001, 2003), 4- the use of different modes of feedback provision (Morris and Chikwa, 2016; McCarthy, 2017), 5- the role of feedback in revision of writing products (Jonsson, 2012), and 6- the role of self-and/or peer assessment (Taras, 2001, 2003), and 7- the importance of the writing process itself (Cloutier, 2016). Each of these techniques contributes to improved insight into the development of academic writing skills. However, one of the most powerful single influences on achievement is feedback (Hattie and Timperley, 2007). This study focuses on the impact of feedforward on specific academic writing skills of pre-service teachers. Some of these include the use of content-specific language, the understanding of developmentally appropriate information about learner needs and differences, the depth of reflection and the use of constructive discussion of observed events, and the use of a wide range of content-specific vocabulary used that contributes to meaningful communication.

Impact of feedforward on students' critical thinking skills

Critical thinking is defined by Scriven and Paul (2003) as the process to conceptualize, apply, analyze, synthesize, and/or evaluate

information collected from observation, experience, feedback, reasoning, or communication, as a way to believe and act. Critical thinking includes attitude, value and character; in other words, the whole being (Ekahitanond, 2013). The critical thinking skills focused on in this study revolved around acquiring and utilizing information, making valid conclusions, and selecting and integrating the appropriate supporting materials through the constant feedforward feedback given periodically after every assignment. Hill and West (2019) stated that feedforward helped in enhancing the whole learning experience for students by facilitating their long-term development. In large classes, it becomes very difficult for a lecturer to provide personalized feedback to support every learner. However, a study conducted by Rodriguez et al. (2022) concluded that even when the lecturer did not give individualized and personalized feedback, the students received enriched formative feedforward, and their critical thinking skills improved progressively from one assignment to the next. The model used in this study was when the lecturer gave general comments to students as feedforward in combination with anonymous personalized peer. Each student appreciated the fact that they not only received feedback but also gave feedback to their peers which contributed to the progress of their critical thinking skills. Furthermore, a study done by Ekahitanond (2013) revealed that students' critical thinking skills and attitudes increased significantly and correlated positively to using peer feedback strategies to learn content.

Another study conducted by Gashan (2015) revealed that pre-service teachers had positive impressions about the value of teaching critical thinking despite the lack of confidence in their own abilities in it. They expressed uncertainty as to whether they had the necessary skills to promote critical thinking in their students. The same study by Gashan (2015) recommended that education preparation programs need to be reviewed, and specialized courses in critical thinking skills need to be incorporated. Pre-service teachers' knowledge about critical thinking should be enhanced to enable them to reflect on what skills they apply in their future teaching duties. In Australia, Bahr (2010) findings showed that nurturing pre-service teachers critical thinking skills is best done through teaching critical thinking. Hence, it is essential that faculty know what critical thinking is and how it can be implemented in the subjects that they teach (Bahr, 2010; Abasaid and Ferreira, 2022).

Methodology

Research design

This study followed an action research design using a mixed-method approach to investigate the problem and find effective solutions using a systematic approach (Stringer, 2007; Gay et al., 2009). This research design focuses on a specific situation (i.e., improving critical thinking and academic writing skills among pre-service teachers) and localized solutions (i.e., using feedforward). Teachers who are involved in action research are believed to improve the quality of teaching and learning inside their classroom mainly because they examine their teaching practices and find solutions to teaching and learning problems (Gay et al., 2009; McNiff and Whitehead, 2011). Hence, the teacher researcher followed a pre- and post-test approach to collect quantitative data and a survey approach to collect qualitative data to investigate the effectiveness of using

feedback as feedforward to improve Emirati pre-service teachers' academic writing and critical thinking skills.

Participants and procedures

This study followed the same cohort of 14 Emirati undergraduate female pre-service teachers and the same instructor for two semesters during the academic year 2021–2022. Participants were enrolled in the first Practicum course and then the second Practicum course in two consecutive semesters. At the beginning of the first semester, the teacher noticed that the low student performance on their reflections was mainly due to their limited academic writing and critical thinking skills. The different techniques and best practices included: discussions, peer feedback, collaborative projects, and problem-based learning. When these were made available to improve students' critical thinking skills, the instructor adopted the feedforward strategy for its benefits mentioned in the section above. Pre-service teachers were expected to carry out six classroom observations during the first semester and another six in the second semester. After each observation, participants were required to write a reflection in English that used analytical and critical thinking skills when reflecting about the teaching and learning environment.

Participants' ages ranged between 18 and 20. They were all Arabic speaking, and the majority (86%) had graduated from public schools that follow the Ministry of Education curriculum. The teacher, PhD in Education studies, has been teaching the same course at the same university for over 3 years. She at once identified the problem, implemented the use of feedforward on each of the pre-service teachers' reflections, and collected both numerical and qualitative data to explore its impact on developing participants' academic writing and critical thinking skills. Hence, pre-service teachers were provided with feedback on their reflections and were asked to improve their following reflection by taking this feedback into consideration. This feedforward strategy was implemented on the participants' 12 reflections throughout the two semesters.

Data collection

After obtaining the ethical clearance from the institutional review board at the beginning of the action research project, the teacher (who is also one of the researchers of this study) used the critical analysis and academic writing rubrics as the first tools to collect quantitative data throughout the first and second semester after each participants' submission of their written reflections. The critical thinking rubric and the academic writing skills rubrics were adopted from the Foundation for Critical Thinking (n.d.) and from the same university, respectively. The critical thinking rubric collects participants reflective skills based on different criteria (acquiring and utilizing information, making valid conclusions, and selecting and integrating the appropriate supporting materials). The academic writing skills rubric focused on the participants' use of content-specific language, developmentally appropriate information about learner needs and differences, depth of reflection and use of constructive discussion of observed events, and a wide range of content-specific vocabulary that contributes to meaningful communication. The two rubrics used to analyze participants

reflective and academic writing skills were based on a scale ranging from 1 to 4, from not evident to exemplary.

The second tool is a qualitative survey developed by the teacher to collect participants' perceptions about the use of feedforward and how it assisted them to develop their academic writing and critical analysis skills. The survey, which included a total of 12 open ended questions, was distributed to participants in class at the end of the second semester. The surveys were anonymous, and the teacher assured participants that the purpose of the survey was to learn about the use of this strategy and its effectiveness to improve their learning and the participation and that it would have no impact whatsoever on their course grades. Survey questions were based on the themes generated from the literature, such as looking at things from a different perspective (Cathcart et al., 2014) and being effective in promoting problem-based learning (i.e., Moallem and Webb, 2016). Other questions were added to clarify a few criteria analyzed in the rubric. Two examples of these questions follow. # 1: Were you able to use the feedback given to help you find information that would help support your position when writing the next observation? Explain how. # 3: Did the feedback provide you with insight into making valid conclusions? How? These open-ended questions gave participants the freedom to express their opinions and add suggestions about the process of using feedforward. Data collected from both tools were combined and analyzed to answer the research questions.

Data analysis

The quantitative data was analyzed using a scale ranging from 1 not evident to 4 exemplary on the rubrics used in both semesters. Data was analyzed by extracting the means of each rubric criteria and comparing student scores at the end of the first semester with their scores at the end of the second semester. Percentages were also calculated to show the performance of participants based on the marks used in the rubrics. Paired sample T-test analysis was conducted through the Statistical Package for Social Sciences (SPSS) software to investigate if there is a significant change in participants' scores following the implementation of feedforward intervention on students' academic writing and critical thinking skills. The Pearson Correlation Coefficient was calculated to examine relationships between variables. As for the qualitative data, participants' responses on the surveys were analyzed through content analysis approach and used to make connections with the quantitative results to triangulate the results and increase reliability of the study findings (Creswell, 2014). The process of the content analysis approach began by having the researchers developed a pre-defined set of categories (i.e., looking at things from a different perspective, receiving constructive feedback, using feedback to find relevant information, using feedback to make valid conclusions). Then each researcher was assigned with set of texts and each one analyzed and coded the content of the text based on the pre-defined categories but also allowed flexibility to add emergent categories (i.e., motivation). Similar codes ones were merged to summarize the data and to identify similarities and differences in participants answers. The researchers met to agree on the final list of codes in order to increase the reliability of resultant codes (Creswell, 2014).

To increase the reliability of resultant codes and themes, the researcher sent various interview transcripts and the list of codes to

her coder colleague in order to obtain agreement on the final codes. All identified themes and sub-themes were organized in Table 1 below. These themes provided evidence that sustainable PDs support teachers in their roles and hence enhance the learning experience.

Results

Analysis of the quantitative data regarding the impact of feedforward revealed minor improvement in their critical thinking skills. The first semester results are calculated as the average of the first six reflections done and are considered as pre-test results to enable comparison between means between the first and second semesters. The total number of reflections for the first semester is $N = 84$ (14 pre-service students x 6 reflections). The results are as follow: 0% indicated (1—not evident); 14% indicated (2—emerging); 72% indicated (3--proficient); and 14% indicated (4—exemplary). At the end of Semester 2, the same critical thinking rubric used for the first semester reflections was used to grade participants' critical thinking skills in the last six reflections done and the scores ranged from 1 to 4. The total number of reflections for the second semester is $N = 84$ (14 pre-service students x 6 reflections). These scores, considered as post-test results were as follow: 0% indicated (1); 1% indicated (2); 79% indicated (3); and 21% indicated (4). The qualitative results validate this finding in particular when participants were asked about whether the feedback helped with looking at things from a different perspective while conducting their reflections. Nine out of the 14 participants said *yes*. One participant mentioned, "… the feedback given by the instructor on my reflections made me think as a teacher and use my thinking skills to find ways to better support the students." Another participant mentioned, "Now I know the correct way to write and show critical thinking skills when writing reflections."

When looking at the mean score of each criterion for measuring the critical thinking skills on the pre and post-test results (Tables 1, 2 below), it was evident that participants' scores improved on each criterion. The largest improvement is seen in the criteria related to "understanding the problem" and "concluding information" with a mean difference of 0.52 and 0.53, respectively. Students showed minimal improvement on one criterion namely "acquiring information" with a mean difference of 0.02 between the post and pre-test results.

A paired sample T-test showed a significant difference in participants' academic scores in the pre-test ($M = 2.84$, SD = 0.48) and post-test ($M = 3.08$, SD = 0.33), $t(13) = -2.74$, $p < 0.05$(two-tailed). Given the eta squared value of 0.33 we can conclude that there was a small effect, with a substantial difference in the critical thinking scores obtained before and after the intervention.

As for the impact of feedforward on participants' academic writing skills, the analysis of data revealed noticeable improvement. The pre-test results are the average of the first six reflections done. The percentage of pre-service teachers indicated: not evident (1), emerging (2), proficient (3), and exemplary (4) at the pre-test were 0, 40, 53, and 7%, respectively. The results of the post-test results at the end of Cycle 2 are the average of students' scores on the last 6 reflections done. The same academic writing rubric used for Semester 1 (pre-test) reflections was used to grade the academic writing skills in the last six reflections done with the scores ranging from 1 to 4. The percentage of responses indicted the following result: 0% indicated (1) 7% indicated (2) 73% indicated (3) and 20% indicated (4).

Qualitative results corroborate this finding, as 10 out of the 14 participants who completed the qualitative survey said that the feedback provided support to improve their writing in their next reflection. The feedback included valid examples and helped the participants to make valid conclusions. As one participant mentioned, "I had detailed feedback on every mistake I made and that allowed me to improve my next reflection and I got higher grades after fixing my mistakes." Another participant said, "I was able to provide good structural sentences that were relevant due to the feedback."

A paired sample T-test was conducted to evaluate the impact of the intervention on participants' academic writing scores. There was a significant difference in their academic scores on the pre-test ($M = 2.64$, SD = 0.63) and post-test ($M = 3.05$, SD = 0.45), $t(13) = -3.54$, $p < 0.005$ (two-tailed). The mean increase in the scores was -0.41 with a 95% confidence interval ranging from -0.67 to -0.16 after implementation of the intervention. Given the eta squared value of 0.95 we can conclude that there was a large effect, with a substantial difference in the academic writing scores obtained before and after the intervention.

When looking at the mean score of each criterion for measuring the academic writing skills on the pre and post-test results (Tables 3, 4 below), it was evident that students' scores improved on each skill except for the language criteria (mean difference = -0.34). The largest

TABLE 2 Critical thinking post-test mean and SD.

	Min	Max	Mean	SD
Understand problem	3.30	4.00	3.70	0.29
Acquire info	2.00	3.50	2.92	0.39
Utilize info	2.30	3.80	2.84	0.47
Conclude info	2.70	4.00	3.06	0.39

$N = 84$.

TABLE 1 Critical thinking pre-test mean and SD.

	Min	Max	Mean	SD
Understand problem	2.30	4.00	3.18	0.47
Acquire info	2.20	3.80	2.90	0.51
Utilize info	2.00	3.70	2.75	0.53
Conclude info	2.00	3.70	2.53	0.54

$N = 84$.

TABLE 3 Academic writing pre-test mean and SD.

	Min	Max	Mean	SD
Content	1.50	4.00	2.65	0.82
Knowledge	1.30	3.80	2.66	0.86
Depth	1.00	3.50	2.13	0.75
Language	2.70	4.00	3.57	0.39
Reference	1.70	4.00	2.96	0.70

$N = 84$.

improvement was seen in the content and depth criteria with a mean difference of 0.52 and 0.50, respectively.

When evaluating the models of each of the academic writing and critical thinking skills, the adjusted R square showed that for the first skill (academic writing) these variables: content, language, depth, and knowledge predict 99% of the total dependent variable. The independent variables "knowledge" and "depth" made the largest contributions to the model with, respectively, beta coefficients of $b = 0.38$ and $b = 0.31$.

As for the second skill (critical thinking), the adjusted R square showed that these variables: utilizing information, acquiring information, understanding the problem, concluding information, and references used explain 99% of the variance in students' skills. Utilizing information made the strongest contribution (beta = 0.42). All variables made statistically significant contribution to the prediction of the dependent variable critical thinking ($p < 0.05$) except for the use of references $p = 0.41$.

The clarity of the feedback and its consistency with the grades were important factors that increased participants' academic writing and critical thinking skills as reported by majority of participants. When asked about clarity of the feedback, participants responded:

> "Totally, now I know how to write and observe the right way."

> "…It helps me clarify and understand the questions."

As for the consistency of the grades with the feedback given, the participants said:

> "…The more I fixed my mistakes, the higher my grades got."

> "…The feedback was showing the improvement I made…."

TABLE 4 Academic writing post-test mean and SD.

	Min	Max	Mean	SD
Content	2.60	4.00	3.17	0.40
Knowledge	2.20	4.00	3.07	0.52
Depth	2.00	3.60	2.80	0.55
Language	2.20	4.00	3.23	0.49
Reference	2.00	3.80	3.07	0.63

$N = 84$.

Furthermore, 11 out of the 12 participants said that the feedback provided them with motivation to do better on the next reflection, and some mentioned that they were motivated to become creative in their writing. When asked how the feedback was motivating, participants said the following:

> "It felt easier to accomplish higher grades because of how detailed the feedback was."

> "…Because I know that every feedback will improve my next reflection assignment."

> "….Because the instructor gives feedback to make my writing better and I should write information that supports my examples and points."

When examining the relationships between the dimensions of critical thinking and academic writing skills, Pearson correlation coefficient results in Table 5 below showed high significant strong positive correlation with two dimensions in particular with the use of content-specific vocabulary ($r = 0.539$, $p < 0.05$) and with the use of references ($r = 0.569$, $p < 0.05$).

Discussion

Personalized and timely feedback is an instructional strategy that is positively correlated with students' performance (Matcha et al., 2019). This study focused on using feedforward to support pre-service EFL teachers' reflections and improve their academic writing and critical thinking skills over a period of two semesters. Quantitative and qualitative data were analyzed separately but results were combined to achieve the aims of this study and present an overall view of the topic. Findings revealed significant difference in participants' academic writing and critical thinking scores on the pre- and post-test; however, minor improvement is seen when students were evaluated based on the acquisition of the information criteria. This latter is an important skill that enables students to analyze the issue in-depth and make rational evaluations with coherent connections between ideas and the course content, and come up with evidence-based conclusions (Kopzhassarova et al., 2016). This finding also explains the minimal improvement seen in their pre and post-test scores on their overall critical thinking skills. Nevertheless, studies like Bahr (2010) and

TABLE 5 Relationships between the dimensions of critical thinking and academic writing skills.

		Content	Knowledge	Depth	Language	Reference
Understand Problems	Pearson Correlation	0.041	0.218	0.265	0.353	0.353
	Sig. (2-tailed)	0.891	0.453	0.360	0.216	0.216
Acquire Info	Pearson Correlation	0.183	0.374	0.461	0.539*	0.569*
	Sig. (2-tailed)	0.531	0.188	0.097	0.047	0.034
Utilize Info	Pearson Correlation	0.047	0.237	0.240	0.305	0.375
	Sig. (2-tailed)	0.873	0.415	0.408	0.289	0.186
Conclude Info	Pearson Correlation	0.367	0.385	0.501	0.464	0.376
	Sig. (2-tailed)	0.196	0.174	0.068	0.095	0.186

$N = 84$.

Gashan (2015) demonstrated the significance for participants to be engaged themselves in critical thinking tasks to be able to transfer them to their students. According to Dakkak (2011), the curriculum adopted at public schools does not feature dimensions of critical thinking and problem solving skills.

Previous studies concluded that if the feedback contains constructive and individualized comments, it would help students see their strengths and weaknesses and guide them to improve their critical thinking (Gavaldon, 2019); however, findings of this study were inconsistent. It is argued that critical thinking is a very difficult skill to teach at the higher education level if students had not been engaged in these tasks themselves at the K-12 level (Wagie and Fox, 2005). It is the vision of the UAE is to advance the quality of education and become a provider of first rate education; therefore, curriculum designers must reconsider the development of curriculum at the K-12 level to include authentic tasks that would engage students in critical thinking skills to help them become problem solvers and build strategies that would make them better at their workplace. Despite this argument, qualitative results of this study showed that feedforward as a new form of feedback motivated students to perform better on the next task and improved the quality of their reflections. This type of intrinsic motivation was highlighted in the self-determination theory of Ryan and Deci (2000) as a factor that would push individuals to "seek new challenges, extend and exercise one's capacities, to explore, and to learn" (p. 70). As a result, increasing students' motivation in the classroom would make them more productive, committed, and persistent in accomplishing the task and acquiring better results (Lin et al., 2003).

In the context of this study, 14 pre-service teachers observed teaching in action and each wrote a total of 12 reflections in English. Two rubrics were used to assess their academic writing skills and critical thinking skills. The clarity of the feedback, its consistency with the rubric, and the exemplars given by the instructor helped pre-service teachers make valid conclusions and guided them in their academic writing. As such, it is noteworthy to highlight that the use of exemplars when providing feedforward is a catalyst to improve their academic writing skills (Carter et al., 2018). Furthermore, findings of this study showed a significance of 0.95 with a substantial difference in participants' academic writing scores obtained before and after the intervention. This finding is aligned with previous findings of Deyi (2011), Ghazal et al. (2018), Jones (2011), and Schillings et al. (2018) reporting on the association of feedforward on the development of students' academic writing skills.

In this study, academic writing was evaluated based on several criteria, namely: using content-specific language, understanding of developmentally appropriate information about learner needs and differences, reflecting deeply and the using constructive discussion of observed events, using a wide range of content-specific vocabulary used that contributes to meaningful communication. Participants' scores improved on all these criteria except for the last one "using a wide range of content-specific vocabulary that contributes to meaningful communication." Having not acquired enough information about the topic negatively impacted students' ability to build content-specific vocabulary in order to create rich reflections and make connections with the course content. Motivation to read and strong English reading skills are two significant factors impacting the Emirati students' performance and success (Eppard et al., 2020).

This study results show that if we were to improve EFL undergraduate students' critical thinking and academic writing skills, feedforward as a

new form of feedback would be a beneficial tool only when it is not used in isolation; it should be accompanied with other tools that support the development of the language and reading fluency. This is what would generate more interest in doing the necessary research in order to acquire the information and build content specific vocabulary. In the same context of this study, Eppard et al. (2020) found that Listening While Reading is a strategy that had a positive impact on undergraduate Emirati EFL students' reading rate and accuracy which, in turn, improved their comprehension skills and vocabulary and increased their motivation to read when compared with a control group who did not use the same strategy. Another associated strategy could be the use of classroom debates to increase students' engagement with the feedback and improve their critical thinking skills particularly in the online setting (Hysaj and Hamam, 2021). Another tool that could also be beneficial is the use of the peer feedback strategy, but only if students are provided with proper training on how to give effective feedback on formal English language structures and global errors related to the content and organization of writing (Hojeij and Baroudi, 2018). Hence, effective and high quality peer feedback would increase students' performance as they approach the writing process from two different perspectives, as writers and as reviewers (Hojeij and Baroudi, 2018). It would also create awareness of their own writing strengths and weaknesses and raise ownership and autonomy (Gavaldon, 2019).

Implications, limitations and recommendations

This study implies the use of feedforward as new form of feedback is a tool to improve EFL pre-service teachers' academic writing and critical thinking skills provided it is constructive, clear, and rich with worked examples. Most of the time instructors complain that the time constraint deters their capacity to provide detailed and timely feedback (Henderson et al., 2019). If instructors are to adopt the intervention of feedforward and grade the same assignment multiple times, they are advised to make use of peer feedback as support. Integrating peer feedback in the feedforward strategy increases students' performance as it plays an active role in their learning process (Wolstencroft and De Main, 2021). Furthermore, it is recommended that curriculum designers at the K-12 level integrate authentic tasks that engage students with real-world problems and train them on inferring information as a scaffold to the development of their critical thinking skills.

Owing to the importance of technology in student learning, it is also recommended that researchers explore the impact of using videos when giving feedforward to help students improve their writing skills. Researchers are also invited to investigate the use of Yu and Liu (2021) feedforward framework featuring teacher- and peer-scaffolding across the technical, social-interactive and individual levels when showcasing exemplars of academic writing to students.

This study is limited to a small and homogenous sample of 14 Emirati female undergraduate students and limited to the same reflection assignment throughout the whole period, this imposing limitations on generalizing the results of this study to a wider population. However, the qualitative part of the study corroborates the quantitative findings and deepens the results significantly. Experimental research designs, for instance, are needed to investigate the impact of feedforward on their critical thinking skills by comparing two groups with the same assignment, one in English and

the other in Arabic to see if the language is a barrier to the development of their critical thinking skills. Lastly, to increase the reliability of findings, collecting the instructor's perceptions would have triangulated the data and provided a comprehensive picture about the topic investigated (Merriam and Tisdell, 2015).

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 Research ethics committee at Zayed University. Ethical approval number is ZU21_163_F. The patients/participants provided their written informed consent to participate in this study.

Author contributions

SB, SA, and DH performed material preparation, data collection, and analysis. SB wrote the first draft of the manuscript. All authors contributed to the study conception and design, commented on previous versions of the manuscript, and read and approved the final manuscript.

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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Teachers' contributions to the school climate and using empathy at work: implications from qualitative research in two European countries

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This research aimed to reveal the factors that, based on their experiences, teachers consider important in their contribution to a positive school climate and in their relationship with students when it comes to using empathy. Teachers from two European countries—Latvia ($n=83$) and Lithuania ($n=69$)—participated in the research. Data were collected through focus group-based interviews and analyzed using latent qualitative content analysis. The results revealed the teachers' shared understanding of the importance of communication and professional development. However, only Lithuanian teachers emphasized strengthening institutional values and other more collectivistic aspects; the answers of Latvian teachers were specific and suggested more of an individualistic attitude, like allocating personal responsibility to use appropriate instructional strategies. This study draws attention to contextual and cultural factors of teachers' work and actualizes their educational needs.

KEYWORDS

content analysis, educational psychology, empathy, focus group, professional well-being, school climate, student, teacher

1. Introduction

There is an increasing awareness among researchers, practitioners, and policy-makers that schools play an important role in promoting the mental health and well-being of both students and teachers. Social–emotional learning and academic learning have been recognized as equally important and related to the overall climate of an educational institution. The consistent development of students' social–emotional skills and sustaining a positive school climate are expected to bring improvements at both the individual and the system levels. On the individual level, previous research provides evidence that students' social–emotional competence is associated with academic achievement (e.g., Durlak et al., 2011; Corcoran et al., 2018), while higher social–emotional competence is positively related to the learning motivation and behavioral adjustment of children of both genders independently of their socioeconomic status, even at preschool age (Martinsone et al., 2021). Regarding the system level, the WHO's Global School Health Initiative (WHO, 2020) addresses the importance of a positive psychosocial environment in fostering the well-being of all members of a school community. Research shows that positive social–emotional and behavioral outcomes are related to a positive school climate (e.g., Hough et al., 2017).

However, in the building of a positive school climate (including creating relationship-oriented and supportive learning environments, sustaining a student-centered pedagogy, inclusion, non-discrimination, and implementing social–emotional learning), the whole-school approach (as opposed to the separate activities of individual teachers) is of particular importance (e.g., Thapa et al., 2013; CASEL, 2015; Dusenbury et al., 2015). Research asserts the importance of sustaining whole-school efforts to improve the school climate and respect culture-specific norms, beliefs, and values (La Salle et al., 2021). The school climate as a multidimensional construct includes such aspects as norms and values, teaching practices, and interpersonal relationships (Cohen et al., 2009). Thus, educators are expected to be role models, implementing and sustaining productive communication at all levels (with students, parents, colleagues, and the administration), embodying values in their attitude and behavior, and even caring for the school's physical environment.

For them to consciously contribute to a whole-school creation of a positive school climate, the work of researchers and practitioners should encompass a teacher's personal characteristics, knowledge, and attitude, as well as their mental health and professional well-being. Research shows that teachers' social–emotional competence, self-reflection capacity, and perceived well-being help to build more positive relationships with students, discipline them more effectively, and foster students' growth (Hamre and Pianta, 2001; Jennings and Greenberg, 2009). Positive associations between the teacher's well-being and students' academic achievement (Herman et al., 2018) could be explained by the teacher's capacity to adopt more supportive behavior and be successful in their role when they can manage their stress and sustain their personal well-being. Empirically examined positive relations have also been found between teachers' and their students' well-being in such domains as teachers' psychological well-being and students' satisfaction with the school, as well as teachers' emotional exhaustion and students' subjective health complaints (Bilz et al., 2022). Bilz et al. conclude that perceived teacher support has a mediating role in the relationship between teacher well-being and student well-being, proposing to proceed with research on what specific teacher behavior supports their students' satisfaction with their school and, ultimately, students' health. Consequently, consciously investing in a positive school climate and teachers' and students' well-being requires teachers' knowledge, commitment, and skills to implement this knowledge in practice.

Teachers' empathy enhances student learning. It is the degree to which the teacher works to deeply understand students' personal and social situations, to feel care and concern in response to their emotions, and to respond compassionately with a focus on student learning. Teacher empathy is communicated to students through the teacher-student relationship within the teaching/learning of the specific subject (Meyers et al., 2019). Empathy plays a key role in social interactions and relationships, which are prerequisites for teaching and learning. Individuals can respond adaptively by perceiving others' emotional states (emotional contagion), not becoming overwhelmed (emotional disconnection), and engaging with cognitive aspects of empathy (e.g., Grühn et al., 2008; Carré et al., 2013). The situation-appropriate response involves such aspects as an ability to regulate one's own emotions, inhibit automatic reactions, and adapt one's response accordingly. Previous research has concluded that empathy helps to cultivate social interactions, perceive them as more meaningful, and, specifically, that empathetic individuals can better accept negativity (Grühn et al., 2008). Consequently, this could help

individuals to be more effective in complex social environments like educational settings. Grühn et al. also claim that empathy is associated with positive well-being, regardless of age.

However, the recent Eurydice report (European Commission, 2021) states that almost a quarter of European teachers report a negative impact of stress on their physical and mental health. The most frequently mentioned causes of stress in teachers' work are administrative duties and workload, as well as responsibility for students' academic performance, classroom management, and collaboration with parents. In relation to teachers' professional well-being, external conditions such as workload, salary, and physical working conditions are most often at the forefront, with less emphasis given to aspects where they can promote their own and their students' well-being. In their theoretical review, Gray et al. (2017) emphasize that both a positive school climate and teachers' professional well-being have to be supported to ensure that students' developmental and learning needs will be met. Nevertheless, for teachers to take responsibility for their own and their students' well-being, they need to know exactly what to do.

Many programs, handbooks, and recommendations have been developed for implementation in teachers' professional work. The "Learning to Be" project's toolkit (Agliati et al., 2020) is an example of materials developed to equip in-service teachers with practically applicable instruction and formative assessment strategies to develop their students' social–emotional skills. This toolkit provides teachers with teaching strategies applicable to lessons in every subject to foster students' social–emotional growth. Another program addressing students' mental health and teachers' own well-being is the Promoting Mental Health at Schools (PROMEHS) curriculum (Grazzani et al., 2020). However, these tools are typically introduced to in-service teachers as an opportunity for professional development. At the same time, the vast majority of pre-service teacher study programs at universities, besides learning theories, instructional process, and evaluation technology, accentuate classroom management and didactics, with less focus on developing an educator's introspective abilities, social–emotional skills, and their competence to sustain their own mental health in today's educational settings that require constant changes to one's teaching approach (e.g., Hipkins et al., 2018). There is a necessity to educate teachers early on to be capable of adapting to the changing learning environments, addressing the learning expectations and requirements of the student generation, implementing competence development, and using diversity productively (e.g., Gilbert, 2013).

The majority of conclusions on teachers' well-being are based on quantitative measures, assessing such variables as teachers' self-efficacy, exhaustion, and depressive symptoms (e.g., Capone and Petrillo, 2020). However, some recent research (e.g., Beltman et al., 2022) has addressed the importance of collecting qualitative data to add in-depth understandings to survey-based conclusions and to hear teachers' voices. Therefore, to provide qualitative and culturally-specific data and to develop pedagogical implications for further teacher education, the present study aims to answer the following research questions through a qualitative analysis of interviews with teachers:

Q1: How do teachers contribute to a positive school climate?
Q2: How do teachers use empathy in their work?

The aim of the study was to reveal the factors that, based on their experiences, teachers consider important in their contribution to a

positive school climate and in their relationship with students in the classroom when it comes to using empathy. This could help to identify teachers' educational needs in order to establish and sustain environments facilitating their students' academic growth and personal well-being.

2. Research methodology

2.1. Sample

The research participants comprised 152 teachers from two European countries—Latvia and Lithuania. Purposeful sampling was implemented in both countries. In both countries, the teachers participating in the focus groups were from schools involved in the "Teaching to Be" Project (each focus group included teachers participating in the project).

Different authors suggest different sizes for focus groups: Johnson and Christensen (2004) recommend 6–12 people, Langford et al. (2002) and Morgan (1997) suggest 6–10 people, and Krueger (2000) and Kuzel (1992) note that 6–9 people in a focus group is sufficient. The optimal size group is 8–10 people, depending on the demographic and research topic. Group sizes can be as many as 12–15, but it requires a strong moderator to facilitate that many people (Sim and Waterfield, 2019). Focus groups may engage up to 20 participants (Masadeh, 2012). Based on the researchers' opinions about the size of the focus groups and the research design, the researchers in both countries determined that one focus group should have no fewer than 12 and no more than 20 participants.

2.1.1. Latvia

Five focus groups were represented by teachers from five different schools. Two schools were from the capital city (Riga), and three were from other parts of Latvia. All schools were municipality-founded general education secondary schools (grades 1–12). The sample consisted of 83 teachers divided into five focus groups based on their respective schools. During the research, three focus group interviews were organized in each school involving the same groups of respondents. The groups of participants were as follows: Group A—15 participants (14 women, one man) from a town close to Riga; Group B—15 participants (14 women, one man) from Riga; Group C—18 participants (17 women, one man) from a regional city; Group D—19 participants (17 women, two men) from Riga; and Group E—16 participants (all women) from a regional city. Breaking the participants down by geographic area, 34 teachers were from Riga, 15 were from a town close to the capital city, and 34 were from regional cities. In terms of gender, there were 78 women and five men. The mean age of all five focus groups was 41 years old, and their mean teaching experience at school was 23 years.

2.1.2. Lithuania

Five schools—pro-gymnasiums and gymnasiums—were invited to form teacher focus groups. These schools were chosen from big cities, small cities, and rural areas in order to represent the five biggest regions of Lithuania and reveal the multifaceted problems. Representatives of the school administration, parents of students, and students themselves did not participate in the focus groups, so the teachers were free to express their opinions, describe their experiences, and feel emotionally unstressed. Five focus groups with teachers were involved in the research,

and each group was represented by teachers from one school: Group A had 15 participants; Group B had 10 participants; Group C had 15 participants; Group D had 14 participants; and Group E had 15 participants. In total, 69 teachers participated in the research. Breaking the participants down by geographic area, Groups A and B (25 teachers in total) were from major cities, Group C (15 teachers) was from a small city, Group D (14 teachers) was from a small town, and Group E (15 teachers) was from a rural area. In terms of gender, there were 53 women and 16 men. The mean age of teachers in all five focus groups was 44 years old, and their mean teaching experience at school was 21 years.

In Lithuania, a complete teacher's education includes a bachelor's (at a college or university) and a university Master's degree in education studies. In Latvia, the compulsory basic education for teachers is a bachelor's degree in pedagogy.

2.2. Data collection

Data were collected from September 2021 to February 2022 in both countries through focus group-based semi-structured interviews. This method was applied in order to explore teachers' experiences, beliefs, and attitudes by using group processes to stimulate responses and gain insights through participants exchanging views and questioning and challenging each other (Scheelbeek et al., 2020). Following the recommendations of Nyumba et al. (2018) on how focus groups should be conducted, in both countries, every focus group interview took not less than 2 h and no more than 3 h.

A semi-structured focus group interview as a data collection method relies on asking questions within a predetermined thematic framework. However, the questions are not set in order or phrasing (Sim and Waterfield, 2019). It was used as an exploratory tool in this study autonomously by a researcher-moderator in both countries.

The qualitative empirical results presented in this article are related to four interview questions from a common questionnaire consisting of 18 questions asked to each of the five focus groups in the "Teaching to Be" project. These questions for focus groups covered areas relating to teachers' professional role at school, namely school contextual components, learning to learn competencies, and teachers' personal and social competencies.

The semi-structured interview questions asked in focus groups in both countries were related to research questions raised in this study:

Q1: How do teachers contribute to a positive school climate?

Interview questions:
What are the visible, easily recognizable characteristics of your school climate? Please describe the one that you treat as a key characteristic? Why do you say it is the main one among others? Please, provide specific example(s).

How do teachers contribute to a positive school climate in your school? Share your experiences. What expectations do you have regarding a better climate in your school?

Q2: How do teachers use empathy in their work?

Interview questions:
Share your experiences of how you use empathy at work. Share your experiences of best and worst examples from your professional practice.

How does empathy help you manage your emotions, feelings, and behavior in difficult situations at school? Please share specific examples from your professional practices.

2.3. Data analysis

Qualitative content analysis is based on the attitude that text is a data source with valuable information about concrete research phenomena (Kondracki et al., 2002). After grouping the text into subcategories and relating these to categories, the similarities and differences between specific content can be identified (Graneheim et al., 2017; Lindgren et al., 2020). Latent qualitative content analysis means interpreting what is hidden within the text. The researcher then needs to discover the implicit meanings of research participants' experiences that are communicated in their interviews and what is implied rather than stated literally (Krippendorff, 2012). This methodology requires the researchers to be intimately involved in the analytical process and to use concepts to interpret and perceive data (Erlingsson and Brysiewicz, 2017).

Four stages of data analysis were applied, and each stage was performed several times to ensure the data's quality and trustworthiness (see, e.g., Kondracki et al., 2002; Morse and Richards, 2002; Graneheim and Lundman, 2004; Bengtsson, 2016; Erlingsson and Brysiewicz, 2017; Kleinheksel et al., 2020; Lindgren et al., 2020):

1. Decontextualization with open coding: the researchers familiarized themselves with the qualitative data and read through the transcribed texts to obtain a sense of the whole before breaking the text into smaller meaning units. Each identified meaning unit was labeled with an inductively created code, which facilitated the identification of concepts around which the data was assembled into blocks and patterns. The researchers used a coding list with explanations to reduce changes during analysis to ensure reliability.
2. Recontextualization: the researchers checked whether all aspects of the content were covered in the list of meaning units in relation to the research questions. Then, the original text was re-read with the final list of meaning units. Meaning units that were not related to the research questions were excluded from the list.
3. Categorization with condensation: before the researchers created subcategories and grouped them into categories, the extended meaning units were condensed. This means that the number of words was reduced, but the essence of the meaning unit's content was not lost. After the categorization process, the created categories were internally homogeneous but externally heterogeneous as no data fell into two groups and did not fit into more than one group of subcategories. All categories were rooted in the data from which they emerged.
4. Compilation: analysis began once the categories were established. A latent qualitative content analysis invited the researchers to immerse themselves to some extent in the data and to identify implied meanings in texts. The researchers chose particular meaning units for each category to be presented as quotations from the interviews.

Subsequently, both authors reviewed and discussed their separately identified categories before they reached a consensus. The common categories for each question were identified, and differences in categories of teachers' answers were found and discussed.

2.4. Research ethics

Ethical principles, validity, reliability, and trustworthiness regarding the study's research process, research design, methodology, and tools were assessed, and ethical permission to conduct the survey in both countries was received from the Committee for Educational Research Ethics, Educational Research Institute, Vytautas Magnus University (February 17, 2022, Protocol No. 5) and from the Research Board of Vytautas Magnus University (March 1, 2022, Protocol No. 17).

3. Results

To answer the first question about how teachers contribute to a positive school climate, two similar categories from Latvian and Lithuanian teachers' responses were developed, namely, "developing professional capability" and "encouraging the self" (see Table 1).

Developing professional capability includes the following three subcategories: (i) autonomy, which teachers relate to acting freely and creatively at school; (ii) decision-making, which participants connect to cooperation with colleagues while working in groups; and (iii) continuous learning, which teachers link to professional growth and the opportunity to engage in various activities with colleagues while being a role model for students and the school community.

Encouraging the self consists of three subcategories: (i) adapting to innovations and changes, which relates to teachers' ability to adjust to rapid changes that cause them a sense of uncertainty, and since these changes will occur for a long time, flexibility in attitudes to professional activity is essential; (ii) improving competences, which reflects the variety of learning methods teachers use—studying in higher education institutions, learning in formal courses, and daily experiential learning while working with students in the classroom; and (iii) leading in multiple contexts, which means leadership in a variety of contexts and formal and informal activities.

The results show specific differences in experience-based perceptions among Latvian and Lithuanian teachers regarding their contribution to a positive school climate (see Table 2).

Latvian teachers view personal connections, solving problems, and maintaining the school's physical environment as important in maintaining a positive school climate. Teachers accentuated the importance of building positive relationships with students and fellow teachers while organizing informal activities and implementing team-building. They also emphasized the importance of accessible administration, conflict resolution, regular team meetings, the opportunity to debrief in a situation of increased stress, and attention to the school's physical environment.

Lithuanian teachers talked about supporting institutional values by highlighting mutual respect, dignity, humaneness in teacher-student, teacher-teacher, and teacher-administration relations, and sustainability as the necessary characteristics of a positive school climate. They see meaning in strengthening the school community,

TABLE 1 Content of similar categories in Latvian (*n*=83) and Lithuanian (*n*=69) teachers' answers to the question "How do you contribute to a positive school climate?"

Category	Subcategory	Quotes from interviews (Lithuanian interviewees, *Latvian interviewees*)
Developing professional capability	Teacher autonomy	My autonomy is related to creativity. If I can act freely and creatively at school, then I can contribute to a better school climate and culture. Autonomous decisions, the opportunity to talk openly, and knowing that you will not be punished spreads the teacher's wings of creativity.
		I wanted to organize the Christmas party and be Santa. The administration supported the plan and provided me with all the attributes.
	Teacher decision-making	The decisions I make both individually and when working in groups or teams are an important part of my professional creative development. When I am heard, I am listened to and my ideas are accepted; if they are not, there is a rational explanation. It is that decision-making that reflects my creative potential.
		We are quite free to collaborate with colleagues. We can decide to have an idea for the topic of the lesson, for example, to lead the lesson together or to implement one topic in several subjects. There, in particular, our freedom is not restricted.
	Continuous learning	The continuous learning of a teacher is an inspiring example for students, their parents, and the entire school community. A teacher's mission is to help students and the general public realize that learning never stops if you are open, flexible, and proactive. This always contributes to the development of creativity, and this allows you to work in various groups, teams, and projects, make various professional choices in life, and discover hobbies. I think that's how I contribute to the idea that students need to love learning.
		The school administration organizes supervisions.
		The school participates in all available projects in Latvia. It promotes professional growth, and each of us gives something to each other—experience, reflections.
Encouraging the self	Adapting to innovations and changes	I think there is resistance only because there is a heavy workload and a lack of information—how it is useful for the teacher, the student, the school. Therefore, talking with teachers and making decisions about innovation together is essential. However, we cannot always manage the situation because a significant part of innovations comes from outside, from the ministry, from politics—then, whether you like it or not, you have to implement it. And flexibility is necessary both as a person and as an expert on the subject. And for that, you need to motivate yourself, enable yourself to constantly 'be on the wave' by learning, observing, adapting to the context, situations, circumstances, but not forgetting your professional role and mission.
		The feeling that no one is really listening to us since the new education reform; there is a lot of uncertainty and a lack of information in the reform itself. In that uncertainty, the teacher is held hostage, and this leads to burnout.
	Improving competencies	When I think about competencies, the first thing that matters to me is my educational subject—to follow it and to know all the innovations. This is related to didactics—to teach in such a way that students understand and learn, and their learning and achievements can be seen as the results of their own efforts. I dedicate time and effort to learning—qualification improvement courses, participation in seminars, conferences. I also spend time working with students, talking to them, trying to understand them. And this is also a kind of improvement of competencies. So alive, so realistic.
		The school's administration recommended that I also become the English teacher. I was supported during my studies and received study leave before graduating.
	Leading in multiple contexts	I see the existence and need for my leadership in many different ways. It is difficult within my subject, teaching, student learning, interactions among fellow teachers, and decision-making from the classroom to the whole school level. But that teacher leadership must be allowed and visible, supported and positively received. It is important that the teacher is seen as learning, able, and capable. I assume leadership in various contexts—organizing excursions for students and fellow teachers, initiating events, talking with students' parents, solving students' educational and social problems. I must occupy multiple roles at once.
		I try to get a student who is an authority in the class to be on my side. If successful, the student in the class also sets the tone and helps maintain order. Then it's easier. I'm not alone then, we are a team.

practicing social sensitivity in relation to the situation, context, and person.

There were also similarities in what teachers from both countries said about using empathy at work. To answer the second question about how teachers use empathy in their professional work, four similar categories from teachers' responses in the focus groups were developed.

Teacher-student communication includes the following four subcategories: (i) teachers' attentiveness to students, which is based on regular observation and building awareness of students' needs; (ii) talking sincerely with students; (iii) maintaining equivalence in mutual conversations; and (iv) maintaining respect and dignity in mutual conversations.

TABLE 2 Content of different categories in Latvian (*n*=83) and Lithuanian (*n*=69) teachers' answers to the question "How do you contribute to a positive school climate?"

Category	Subcategory	Illustrative quotes from interviews
Latvian teachers		
Building personal connections	Personal interest	I am interested in how the students have spent their holidays.
		I really try to memorize my students' names and use them both in class and when meeting students in the hallway or outside school. I see that some children are pleasantly surprised that I remember their names.
		I am really interested in what happens to students in their free time. I always ask how they are doing, and they are not afraid to ask what I do either. When I say that I like to run and ride a bike, they are amazed that we do the same things as they do.
	Informal activities	We organize common parties, events, and trips.
		We organized the "Night at school" event—students prepare dinner in the school cafeteria, go on a night tour of the school, sleep in class, etc. Such activities strengthen the relationship between teachers and students and also between students.
		A positive climate is also created by small groups, where people come into contact more often and create a microclimate. We talk about everyday things and feelings.
Problem-solving	Team-building through professional relationships	Working groups for teachers representing the same subject area.
		Collaboration between subject teachers—parallel class teachers work together to develop tests and uniform requirements and exchange experience and teaching materials.
	Access to administration	As you walk through the hallway, the doors of the administration staff are always open; you can enter and ask questions.
	Sustainability of the team	Twenty-five of us—teachers and administration staff—have graduated from this school.
	Reframing conflicts	When there is a conflict in my class, I always ask, "How can I help you?" instead of asking who is guilty. I have seen that my students now use this approach independently in their conflicts.
	Debriefing	I went to the vice-principal and told her how bad everything was. She let me complain, but she also helped me to calm down.
	Regular meetings	Every Tuesday, we have a small information meeting—it keeps you disciplined, you find out the news, colleagues remind you what has been forgotten and what needs to be done; it motivates you and makes you feel informed and inside the process.
Physical environment	Coziness	Our school is cozy. It is a cozy environment. I like the layout of the school, the warm colors in the classrooms, the newly renovated premises. We create our own environment; for example, we once even put curtains over the windows.
	Providing structure	We have pictograms to regulate the order in which people speak.
Lithuanian teachers		
Strengthening institutional values	Respect	Respect each other in the classroom and at school. Between the teacher and student, teacher and teacher, and teacher and school administration, in the whole school community. Through real actions. This must be reflected everywhere – in conversations, in correspondence (emails and comments), in our decisions. There is still a lot of work to be done to learn to hear each other, to listen, to cooperate, to criticize, to make decisions, to solve problems. We can maintain a positive atmosphere in the school only if we all focus on fostering mutual respect.
	Dignity	Dignity is often declared, but it is still difficult to find it in actions and cooperation. Although there are positive signs. Here, the teacher plays an important role through their example. Therefore, the responsibility is great.
	Humaneness	Humaneness is reflected in all the teacher's actions—from assessments to conversations with students. This does not mean pandering or trying to please the student; it is closer to social sensitivity, being aware of the situation, the context, and the person.
	Sustainability	Sustainability is an important value of the school—to live in peace with nature, to contribute to a school's ecology physically, morally, and socially. It is a complex learning process where a single teacher cannot do much. Therefore, strengthening the school administration and mobilizing the entire school community plays an essential role here.

Supporting students consists of the following four subcategories: (i) helping students to solve learning difficulties; (ii) listening to and hearing students' opinions'; (iii) teachers' attentiveness to a student's family context, which takes into account a wider ecosystem of the learning process; and (iv) providing targeted help through an individual approach to every student in need.

Teacher-parent communication comprises the following three subcategories: (i) involving parents in their child's learning by

establishing relationships in order to facilitate students' learning motivation and achievements; (ii) providing targeted counseling to parents to support their child's learning and well-being; and (iii) finding a solid basis for consensus with parents and preventing problems when a conflict could arise.

Teacher-teacher communication involves the following two subcategories: (i) mutual professional support, providing a secure base for teachers' professional growth, and (ii) mutual professional respect and dignity as a fundamental aspect of a teacher's work and a channel through which to use empathy (Table 3).

Several country-specific differences emerged from the qualitative data regarding teachers' use of empathy in their professional work.

Based on the Latvian teachers' answers, two different categories were developed, namely, *Classroom instruction* and *Teacher's personal responsibility* to create space for empathy. Latvian teachers use empathy through the content of the subject (e.g., history), classroom management strategies, and adapting their teaching methods and classroom management to their students' learning needs. In terms of the teacher's personal responsibility, Latvian teachers use empathy by creating a positive mood in the classroom and at school and changing expectations and perceptions regarding students' learning process and needs.

Lithuanian teachers use empathy by supporting students and communicating with students' parents and fellow teachers. They also mentioned giving timely feedback to students, the attentiveness of students' parents in listening to their opinions and expectations regarding the child's learning, and openness to fellow teachers in solving problems and making decisions as instances of using empathy in their professional work (Table 4).

4. Discussion

4.1. How do teachers contribute to a positive school climate?

Both Latvian and Lithuanian teachers said that they contribute to a positive school climate through their capability of acting autonomously, making decisions individually and with fellow teachers, learning continuously, and being role models to students and the school community. These results show that the school climate is not just an individual experience. A positive school climate fosters teachers' professional development and students' learning, and vice versa—teachers' professional development contributes to a positive school climate. The school's norms, values, and expectations can support the school community in feeling socially, emotionally, and physically safe. Other authors have suggested that this could mean that teachers form and nurture an attitude that emphasizes the benefits of learning (Cohen et al., 2009).

This research aimed to reveal factors that teachers consider important in their contribution to a positive school climate and in their relationship with students when it comes to using empathy. Only Lithuanian teachers emphasized strengthening institutional values and other more collectivistic aspects. Conversely, the answers of Latvian teachers were specific and suggested more of an individualistic attitude. Taken together, the attitudes of Latvian and Lithuanian teachers form an optimal model that integrates individual and collective community aspects. However, they are

both specific to the context of the school. A positive school climate is a combination of personal, communal or collective, and contextual factors that increase prosocial interpersonal relationships among students and decrease problem behaviors (Zych et al., 2019). Contextual factors influence teachers' decision-making regarding teaching and learning since social interactions, culture, society, technology, and other contextual factors are learning assets. Students come to class with different learning standards and attitudes toward learning. This is related to biological factors, family contexts, cultural aspects, socioeconomic dynamics, and other assets affecting students' learning. Thus, when teachers discuss their expectations with students regarding their learning and outcomes, they should take into account all these factors.

The pedagogical environment designed and facilitated by the teacher plays a role in students' creative development, which builds the school's positive climate (Anderson et al., 2021). However, despite speaking about the same aspects of building a positive school climate, only Lithuanian teachers talked about creativity; Latvian teachers did not highlight this aspect in their answers. It is possible to speculate that this is because there is a difference in teachers' pre-service education. In Lithuania, a complete teacher's education involves obtaining a Master's degree, which includes developing an understanding of educational philosophy. In Latvia, the minimum pre-service education is a bachelor's degree in pedagogy or any other specialty together with a brief 72-h course in pedagogy. Consequently, teachers' education in Latvia has been more practically oriented until now, addressing classroom management, didactics, and assessment. Only during the last several years have such courses as social–emotional learning in schools been introduced to pre-service teacher education programs. Another explanation could be that in Latvia, creativity is attributed more to students' performance than teachers' professional work.

Encouraging the self is the other category that emerged from the answers of teachers from both Latvia and Lithuania. In building a positive school climate, teachers encourage the self by adapting to innovations and change and improving competencies and leadership in different contexts. These findings are consistent with the attitude of Kachnic and Berkowitz (2022), who note that teachers play a vital role in offering stability, a sense of belonging, and social relationships that can promote their learning to students. Teachers accomplish this by being flexible to innovations and change, open to other attitudes, critical of stereotypes, and self-critical, challenging their professional comfort. Teachers from both countries also emphasized the negative side of rapid changes in education that could diminish their capability to invest in building positive learning environments (i.e., by facing continuous changes, the teachers' approach could become more about surviving than thriving). However, teachers' professional and/or competence development is a crucial factor that contributes to a positive school climate. Teachers increase their mindset and their abilities to support and address the social and emotional needs of students and themselves through competence improvement (Durlak et al., 2011). A positive school climate and teacher leadership have both been shown to have beneficial effects on student achievement. Teacher leadership implies that teachers hold the key role in teaching and learning. In this way, teachers are

TABLE 3 Content of similar categories in Latvian (*n*=83) and Lithuanian (*n*=69) teachers' answers to the question "How do you use empathy in your work?"

Category	Subcategory	Quotes from interviews (Lithuanian interviewees, *Latvian interviewees*)
Teacher-student communication	Teachers' attentiveness to students	The teacher's attentiveness at every step, in every context, in every situation. Do not be little, do not compare with others. This allows the teacher to maintain a good atmosphere in the classroom. By paying attention, the teacher shows empathy.
		If I see that children are exhausted, I will try to find a more interesting and slightly easier task to do in my lesson.
	Talking sincerely with students	Sincerity in the relationship with students is best reflected in conversations. And there are all kinds of these—both problematic and unproblematic, simply talking about an experience among themselves. Without sincerity, the relationship is cold, insensitive. Therefore, it is an important quality that does not need to be hidden and suppressed. It is not like or dislike. This is heartiness.
		We come to work to see smiling faces and feel welcomed.
	Maintaining equivalence in mutual conversations	Equality in conversations between teachers and students is essential. It is not the quality of frivolity. This is another characteristic of respect without crossing moral and ethical boundaries. It is an opportunity for both the teacher and the students to grow, develop, and show their best sides.
		I speak about my emotions openly. I said that I was so overwhelmed that I had not had time to prepare for the lesson. The students were empathetic, and our relationship improved after this lesson.
	Having respect and dignity in mutual conversations	Mutual respect and maintaining dignity in conversations between teachers and students is essential. We learn this every day. This is the path to intelligence. This is what I always strive for and want. The students feel it. And I feel their efforts. It is inseparable from ethics and morality and personal responsibility for one's words and actions.
		We respect the one who speaks.
Supporting students	Helping students to solve learning difficulties	Support for students is considered very direct when targeted to solve learning problems. This happens in various ways—by recommending, talking, showing, presenting examples, discussing, giving reading suggestions.
		I handed out white sheets of paper to the children, and every time they wanted to say something that was not relevant to the lesson, they wrote it on that sheet. It helped alleviate the students' emotions that prevented me from leading the lesson. *We have a rule that a test can be rearranged within two weeks, but if I see that the student is overloaded and does not have the opportunity to rearrange the test now, we can agree that they can come to it later.*
	Listening and hearing to students' opinions	Listening to students' opinions and attitudes means showing support for them. Not only respect. It means speaking and talking, expressing visions and sharing them with them, and learning to think critically and politely to talk about all kinds of topics. No matter whether they are hard or difficult.
		I often ask students, "What do you think?" It's easier to emphasize that I may not know something and I can ask for help.
	Being attentive to a student's family context	Students are related to their families and therefore to their family context. It is always individual, authentic, sensitive. Therefore, my attention to the student's family context is an integral part of teaching and a component of my private ethical communication with them.
		I'm too empathetic. I accidentally fell into the role of a student's mother. I think about what I would do if I were this student's mom.
	Providing targeted help for students	Targeted support for students is important. Not for everyone, but for individuals. I understand this very well, and I always help in a targeted way.
		I usually have a coloring book in my bag. There have been situations where a student in the class has been aggressive, dissatisfied. I suggest to this student that they paint a page of their choice in this coloring book. The student usually calms down fairly quickly and can continue working in the classroom.

(Continued)

TABLE 3 (Continued)

Category	Subcategory	Quotes from interviews (Lithuanian interviewees, *Latvian interviewees*)
Teacher-parent communication	Involving parents in their child's learning	It is not easy to consciously involve parents in their child's learning. But it is necessary. Their involvement is directly related to the child's learning motivation and achievements. Then the child does not feel alone and lost. A teacher is not enough. Therefore, we spend a lot of time with the children's parents: we talk, argue, discuss, reach a consensus, and talk about their obligations to the child and their future.
		I call parents not only when a student has done something wrong but also when they have behaved well. Usually, the parents are surprised, and the child really tries to behave well over the next few days.
	Providing targeted counseling to parents	Targeted consultations for parents regarding the child's learning, well-being, emotion management, and behavior are common topics. I myself learn a lot and share my experiences with them. The most important thing for me is the child. They should love learning and feel good so that learning becomes daily hard work but without coercion. Parents must be involved. Therefore, I provide targeted consultations and devote a lot of time to jobs. I think this is one of the prerequisites for my success in working with students.
		After receiving a low grade on a test, the student cried. I said I'd call her mom and explain everything, that she had nothing to worry about.
	Finding a solid basis for consensus with parents	Finding a solid basis for consensus-based decisions with someone's parents is not easy, but in many cases, it is possible. I spend time and effort on this. But I do it with love and openness. Because I'm doing it for the sake of the child. And in those conversations with parents, we learn both sides—we listen, we hear, we are patient and open, non-judgmental, so we grow and learn from each other.
		When there are conflicts, I try to keep the peace, do not raise my voice, do not look for the culprit, and continue the conversation calmly. Then the students or parents also remain calmer. I focus on the current situation, ask questions and try to gather as much information as possible.
Teacher-teacher communication	Mutual professional support	Mutual professional support among teachers is one of the prerequisites for survival in the teaching profession. It is related to methodological solutions, solutions to problems in teaching and learning, creative initiatives, preparation for lessons and competitions, and countless other aspects. It requires teachers' kindness, flexibility, and openness. It is part of the culture of communication formed by teachers and the school administration. You will feel safe as a professional if such a culture is supported in the school. I have been living in this culture for two decades. This is professional happiness.
		A sense of security is provided by colleagues, and they also provide support.
	Mutual professional respect and dignity	Mutual professional respect and dignity are inseparable from a teacher's professional well-being in school. These include self-esteem, self-worth, mutual trust, openness, flexibility, friendliness, honesty, and selflessness. There is no place for egoism and egocentricity and narcissism. Ethics and morality, responsibility and duty are what is required.
		I know that if I am sick, then a colleague will be obliged to do my work too. This is why I keep doing what I can for as long as I can, and I always bring some sweets when a colleague has helped me.

given the professional power to be a part of creating a positive climate in schools. Thus, teachers' self-encouragement through their leadership becomes an important component of a school climate (Gningue et al., 2022).

Several country-specific differences emerged when the teachers spoke about their contributions to a positive school climate. Latvian teachers accentuated building personal connections, solving problems appropriately, and maintaining their school's physical environment. Teachers shared their experiences of building positive relationships through expressing personal interest in their students' learning and achievements, echoing finding of Eccles (2008) that building strong personal relationships is an important part of creating a positive school climate. Latvian teachers also saw organizing informal activities to mobilize the school community and providing team-building activities with fellow teachers through professional relationships as part of creating a positive school climate. This is consistent with the conclusion of a recent systematic review that social relationships play a central role in predicting teachers' well-being, which consequently influences their teaching quality (Hascher and Waber, 2021). These results also support the research of Greenway (2017), who shows that a well-maintained school environment improves students' achievement on standardized tests and is linked to increased teacher commitment.

For Latvian teachers, the physical environment, accessibility of the school administration, professional teamwork, and resolving conflicts are inseparable parts of the school climate. These answers align with the conclusions of other researchers that the construct of a school climate is multidimensional (see, e.g., Thapa et al., 2013; La Salle et al., 2021) and involves such aspects

TABLE 4 Content of different categories in Latvian (*n*=83) and Lithuanian (*n*=69) teachers' answers to the question "How do you use empathy in your work?"

Category	Subcategory	Illustrative quotes from interviews
Latvian teachers		
Classroom instruction	Using subject content	There are so many events in 20th-century history that cannot be talked about without empathy, such as the Holocaust and World War II. When I have to talk about these historical events, I can relate these events to my family's life story and to the experiences of the students' families.
	Using classroom management strategies	I try to ask students how they feel. Then if some say that something is wrong, I ask what could help them. If, for example, a child says that silence in the classroom would help him, the whole class tries to respect it more. The classes I remember asking them how they feel usually go better because then I can remind them, "Hey, we agreed that there would be silence in the class."
	Adapting teaching methods to students' learning needs	I try to watch the kids for a full school day. The aim of the observation was to see how children behave from 1 h to another and how the child endures those seven hours. I noticed that it is difficult for students to learn if the same teaching methods are used in several lessons, such as using only workbooks. The child no longer follows the lesson because he is tired and uninterested, even though the content is different.
		I evaluate the emotional mood of the students at the very beginning of the lesson, how I can keep their attention on the lesson, and I try to adapt. I adjust to the overall emotional state of the class.
Teacher's personal responsibility	Creating a positive climate	The teacher creates a positive mood; if they come to work positive and smiling, it simply sticks to others.
	Changing expectations	It was difficult for me to understand and accept that my child has difficulties with learning, especially Latvian. A child growing up in a Latvian family does not understand the grammar of the mother tongue! It was a shock, a blow, like a heart attack! And I am a Latvian language teacher. But now, thanks to my child, I understand why my students may not understand much better. I used to be very categorical—I could not understand how a child whose mother tongue is Latvian does not know grammar. I could understand why this was the case for children of other nationalities, but not Latvian. Now, I think differently. I am no longer so categorical. I do not assume that a child understands grammar.
	Changing perceptions	At the moment, when someone is very disturbed in class, I try to change my perception—I turn on the love button and give an inner signal to myself that this is a very nice boy. I look at him and give myself a signal that he is nice. I seem to deceive myself, then my emotions subside, and I can react more calmly.
Lithuanian teachers		
Supporting students	Providing timely responses to students' queries	Timely feedback to students is important and necessary. As it is for all of us adults. Especially when it is related to learning, learning tasks, results, and problems. I understand this, and I try very hard to provide answers to students' queries promptly.
Teacher-parent communication	Listening to parents' opinions and expectations regarding their child's education	Parents are used to demanding. Sometimes I listen to them, and it's hard for me to understand what they want for the child. Therefore, I talk to parents a lot, I try to be their supervisor so that they reflect and consciously focus on their child's learning needs and expectations. I do not think the parents' expectations and wishes for the child's education are higher than the child's. And the child's wishes and expectations must be nurtured and developed by teachers and parents together. The child must also participate in this. It is a complicated process. But very necessary.
Teacher-teacher communication	Being open while solving problems and making decisions	Teachers need mutual openness to make decisions transparently and clearly. Open conversation, openly expressed emotions, openly communicated feelings. When we learn to do this, we want to go to work, we work motivated in groups and teams. We can make difficult decisions and be calm about them because they are clear, ethical, and moral.

as perceptions of peers' and adults' interpersonal relationships, learning environment (including teachers' expectations and material resources), and perceptions of physical and emotional safety. Consequently, a supportive school climate can sustain teamwork and conflict resolution, thus supporting physical and emotional safety. This means that the school climate is not the final outcome but a continuous and dynamic process of improvement. Effective school climate improvement efforts involve students, parents, teachers, and the whole school community (Cohen et al., 2009).

Lithuanian teachers accentuate institutional values—respect, dignity, humaneness, and sustainability. For them, mutual relations, cooperation, and various activities are the responsibility of every member of the school community. They are convinced that the school community only supports the institutional culture and contributes to a positive school climate by implementing such values in practice, i.e.,

in their real-life relationships. Since the school climate refers to various values that are key to the development of a student's personality (Gálvez-Nieto et al., 2022), Lithuanian teachers emphasize communality. Communality is related to more positive behavioral strategies and a teacher's consistent enforcement of rules, which is associated with a more positive school climate (Mitchell and Bradshaw, 2013).

4.2. How do teachers use empathy in their work?

Both Latvian and Lithuanian teachers declared that they use empathy through communication with students, teachers, and parents. In teacher-student communication, empathy means attentiveness, kindness, respect, and equity. Teachers use empathy by supporting students regarding their learning and personal difficulties, respecting their family context, and taking into account their personal opinions. Teachers also provided examples of using empathy in communication with parents by involving them in their child's learning, providing counseling, and striving for consensus. Teachers also use empathy while communicating with fellow teachers by providing mutual support on the basis of respect and dignity. These results match other research-based considerations (Gair, 2009; Gutsell and Inzlicht, 2010) that empathy builds a positive classroom culture, strengthens the community, develops soft teacher leadership, and prepares students to be leaders in their community through the use of teachers as role models. A teacher's soft leadership is related to soft skills and is a process involving striving for teaching/learning goals; having a persuasive influence on students and fellow teachers and forming effective teams; negotiating with others with a win-win attitude and valuing others' failures for learning from them; supporting students and fellow teachers and motivating them for learning, achievements and success; and recognizing others' contributions in implementing teaching/learning goals (Rao, 2017).

Several country-specific differences were found regarding teachers' use of empathy. Latvian teachers consider that they use empathy through a subject's content by using positive classroom management strategies and adapting their instructions to the emotional mood of students in a classroom. Latvian teachers pointed out that it is their personal responsibility to create a positive mood and change dysfunctional beliefs and attitudes. The teacher's capability to manage classroom instruction strategies for students' growth has also been recognized in previous research (Ferreira et al., 2020). Considering the emotional state of students helps to identify, plan for, and implement preventative techniques to encourage positive student behavior, minimize disruptive behaviors in the classroom, and support their learning motivation (Banks, 2014). Nevertheless, the Latvian teachers spoke more about their personal responsibility regarding their use of empathy rather than waiting for collegial or parental support. This is the opposite of their answers about building a positive school climate, when they exclusively spoke about the importance of building relationships. Thus, one could speculate that empathy is perceived as a personal trait, naturally arising in teachers' professional work, rather than as an ability that must be developed in teachers' training.

Lithuanian teachers apply empathy by responding promptly to students' queries and questions. These results support the attitude that learning is an emotional process (Banks, 2014). When students are excited at learning a new skill, they can experience negative emotions about mistakes and situations when they are misunderstood. Thus, operatively provided feedback from a teacher can foster positive emotions in the classroom and serve as a premise for motivation to learn (Greenway, 2017). Lithuanian teachers also emphasized the role of fundamental values (respect, dignity, and kindness) and the importance of collaboration with colleagues by relating it to using empathy at work. This means that empathy is a value desired, supported, and practiced by teachers in different aspects of their professional work. Therefore, Lithuanian teachers' answers represent the attitude (Çakiroğlu et al., 2012; Gálvez-Nieto et al., 2022) that a school climate encompasses the experiences of school community members while teaching and learning, building mutual relationships, and capturing communal beliefs and attitudes. Implementing this whole-school consensus requires individual action, empowerment, awareness, and courage. Therefore, the individual contribution of the teacher to the development and improvement of a positive school climate, emphasized by Latvian teachers, remains relevant (Greenway, 2017).

In short, Lithuanian teachers associate empathy with their community, society, and institution, providing more general statements, while Latvian teachers realize empathy through personalized professional expertise, emphasizing their own individual responsibility. These differences in their answers can be attributed to collectivistic and individualistic cultural orientations. Research in individualism and collectivism is usually related to cultural orientations, defined by whether more emphasis is placed on the individual or group, itself usually attributed to cultural differences between countries (Vu et al., 2017). This finding is not consistent with the existing view that Latvia and Lithuania are both countries of an individualistic culture since Lithuanian teachers' answers are more collectivism-oriented, whereas the Latvian teachers' answers emphasize a more individualistic approach to reflecting on their professional work experiences.

5. Conclusion and implications

The results of the current study show that building a positive school climate and using empathy are of great importance in teachers' professional work. Latvian and Lithuanian teachers claim that they invest in a positive school climate by building such aspects of their professional capability as coping with changes, acting autonomously, implementing leadership, and developing professionally. Specifically, Latvian teachers recognized relationships as an important aspect of promoting a positive school climate, whereas Lithuanian teachers spoke about creativity in their professional work and addressed whole-school aspects like values.

Latvian and Lithuanian teachers similarly recognize that they use empathy in their work through communication with a wide spectrum of partners (students, colleagues, administration, and parents) and in providing support to students. Regarding country-specific differences, Latvian teachers spoke about using empathy through appropriate classroom instruction, taking students' perspectives, and changing their mindsets to adapt to their students'

needs. Lithuanian teachers provided more general statements about how they use empathy at work, emphasizing fundamental values (respect, dignity, and kindness) and the importance of collaboration with colleagues.

The results show a tendency toward a collectivistic culture in the Lithuanian teachers' answers and a more individualistic attitude among Latvian teachers regarding contributing to a positive school climate and using empathy at work. What these differences mean for teachers' contribution to a positive school climate and the use of empathy at work cannot be precisely answered using this dyad. However, if future research on this issue were carried out, it would contribute to our understanding of school psychology and education management in both countries.

Due to the qualitative design and the sample size, this study provides the opportunity to hear teachers' voice to understand their needs in pre-service teacher education to provide knowledge and equip them with skills to build a positive learning environment and promote their students' well-being. This study clearly shows that teachers recognize the need for training in how to establish and maintain positive relationships, sustain organizational values, apply positive discipline, and implement social–emotional learning through everyday teaching routines and formative assessment. This adjusts the implication that psychological readiness and methodological competence must be equally addressed in pre-service teacher education.

The content of curriculums for pre-service teacher training and education needs to be targeted to develop teachers' awareness of their active role in every process at school. Teachers are not external experts teaching, observing, informing, disciplining, and assessing their students and must not just implement competency-based education but must also develop their competencies to become a tool, embodying their own values, rules, and teaching methods.

The findings of this research highlight that the following aspects need to be addressed in pre-service teacher education: (1) the central role of building relationships; (2) the development of teachers' introspection and self-reflection to be capable of contributing personally to building a positive school climate and using empathy; and (3) having an awareness of and taking individual responsibility for sustaining institutional values.

5.1. Strengths and limitations

A strength of this research is that the sample represents different national regions and school types in two European countries. The qualitative study design provided the opportunity to hear teachers' voices to gain an in-depth understanding of their experiences and perceptions of their contributions to creating a positive school climate and using empathy at work. The findings of this qualitative research also made several specific recommendations for developing pre-service teacher education curriculums in the future.

Due to the nature of this qualitative research, the results cannot be generalized as completely representing the societies and countries mentioned. One of limitations can be attributed to the fact that the teachers' educational level was not addressed; however, the minimum pre-service education of teachers in Latvia and Lithuania is different. The gender distribution in the current sample was disproportional; nevertheless, it represents a gender distribution typical of the teacher populations in Latvia and Lithuania. Due to this, there was no possibility of addressing gender differences in the teachers' answers. It is also possible that in a focus group environment, some teachers could not express their opinions in the same way as in an individual interview out of fear or intimidation of the majority opinion.

Data availability statement

The datasets presented in this article can be made available upon request by contacting BM and VŽ. Requests to access the datasets should be directed to baiba.martinsone@lu.lv and vilma.zydziunaite@vdu.lt.

Ethics statement

Author contributions

BM: key contribution to arranging the research in Latvia, collecting and analyzing data, and writing. VŽ: key contribution to designing the research, arranging the research in Lithuania, collecting and analyzing data, and writing. 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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Preservice teachers' experiences with classroom management in the virtual class: a case study approach

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The present study explores the experiences of Emirati female preservice teachers who are completing their internship teaching practice virtually due to the COVID-19 pandemic. This qualitative study focuses on virtual classroom management. Participants were preservice teachers (n =18) completing their undergraduate degrees in Early Childhood Education at a federal university in the United Arab Emirates (UAE). Data collected from interviews resulted in four themes related to classroom management: challenges, opportunities, performance factors, and suggestions for improvement. The findings revealed that the preservice teachers considered virtual learning an opportunity. However, the main challenge was that the preservice teachers had no prior training in online classroom management and had to create their own strategies. Training on the technology used for virtual learning is important for both teachers and students to achieve satisfactory learning experiences.

1. Introduction

It is unquestionably crucial for student teachers to complete training programs while still in school, before starting their future professions and managing actual classrooms on their own. In order to give preservice teachers the opportunity to observe a genuine classroom setting in its actual daily context, a practicum is typically included in preservice teacher training programs. The practicum's main goal is to help preservice teachers develop their field experience skills while being coached by experienced educators. In the past 30 years, several colleges have embraced this more regularly (White, 2017).

Traditionally, most teacher education programs have assumed that teachers can learn everything they need to teach well by completing their programs of study, offering limited opportunities for practicing, often equated with a passive observation of lessons taught by expert professionals (Samu, 2020). However, many aspiring teachers give up their careers as soon as they are placed in classrooms because they find the experience to be extremely terrifying. Field experience, therefore, provides several options to overcome this problem (Taghreed and Mohd, 2017).

Mohebi and Meda (2021) reported that the provision of high-quality education is part of the UAE's key national priority. One strategy for achieving this national target is to improve the

availability of trainee teachers' programs as this is the cornerstone for strengthening the education system.

Equivalently, Anderson et al. (2022) claimed that the experience of preservice teachers in the emergency online learning environment was expected to influence their perspectives of e-learning. Teachers' past experience with e-learning technology is important because students may affect their perceptions about its potential usefulness for learning, future adoption, and usage as pedagogical tools (Anderson et al., 2022).

Kunter et al. (2007) and Junker et al. (2021) stated that although a supportive atmosphere and instructional support are key parts of teaching quality, classroom management is also a requirement for other quality indices (Junker et al., 2021). However, due to the lack of face-to-face contact, dealing with student behavior and attendance difficulties during synchronous learning sessions seems to be an obstacle (Hefnawi, 2022).

Ersin et al. (2020) indicated that the effectiveness of student teaching experiences affected teacher candidates in five categories: (a) pedagogical content knowledge, (b) planning and preparation for instruction, (c) classroom management, (d) promoting family involvement, and (e) professionalism. As such, preservice teachers learn about disciplinary techniques and classroom management through formal training and from their personal experiences. They develop effective classroom management from the duration of service in the related job. Therefore, it can be assumed that teachers will have better classroom discipline management throughout being in the teaching profession. Experience plays a significant role in exercising discipline management in the classroom (Rosilawati, 2013).

2. Literature review

2.1. Teaching online classes

With the outbreak of COVID-19, significant changes marked various aspects of human life, especially the educational systems worldwide. Face-to-face teaching ceased and gave way to a new form on a new platform with new factors. Unfortunately, preservice teachers were mostly at a great disadvantage since this sudden crossing from traditional to virtual classroom teaching occurred at a time when most teachers, educators, and supervisors were not that experienced and skilled in these practices (Sepulveda-Escobar and Morrison, 2020).

Moreover, novice and trainee teachers faced many challenges in their endeavor to harness the newly sought skill of teaching while applying taught educational methods in the new normal of online teaching (Baran and AlZoubi, 2020; Mohamad Nasri et al., 2020; Samu, 2020). These challenges included designing appropriate, differentiating, and effective social tasks for the online environment, managing classroom interaction, and engaging with the electronic constraints of the available platforms such as videoconferencing, live chats, Zoom, or Skype (König et al., 2020; Samu, 2020; Scull et al., 2020). To address these issues, several institutions provided their practicum courses using the reflection-on-action methodology, with their students serving as observers for the online sessions of the professionals (Özkanal et al., 2020). Others employed simulations to hone the classroom management abilities of preservice teachers, providing exceptional opportunities for teaching skill development and reflection (Finn et al., 2020). Furthermore, some educators chose

to confront the difficulties brought on by the unexpected acceleration of the rise of teaching and learning online, giving their students an actual and practical field trial so they could adjust accordingly (Baran and AlZoubi, 2020; Mohamad Nasri et al., 2020). According to Kim (2020), "Online teaching experiences provided these preservice teachers with opportunities to interact with children, as well as to encourage reflection on how best to promote young children's development and learning with online communication tools" (p. 145).

Additionally, current student teachers who will soon be instructors have grown up in a technologically advanced period and are quite familiar with technology's use and applications (Margaliot and Gorev, 2020). However, they encounter challenges in integrating their technological abilities into the workplace when it comes to utilizing their knowledge in active online teaching (Martin et al., 2019). Uniformly, Harasim (2017) stated that although new social communication technologies and media have been embraced in day-to-day life, these tools and platforms have remained limited when it comes to implementation in teaching and learning (Harasim, 2017). As such, it was only in the last two decades that online education grew rapidly (Allen and Seaman, 2014). The online blended mode, which was available to both on-campus and off-campus students, began to affect students (Zawacki-Richter and Anderson, 2014), forcing higher education institutions to shift their emphasis from ensuring that students had access to their education to improving its quality (Lee, 2017).

It is noteworthy to mention that the methods and practices applied in blended and online teaching are quite different from the traditional approaches followed in face-to-face learning settings Thus, the way the teachers are prepared for their teaching is relevantly reflective of the quality of their instructions (Gurley, 2018). According to Dorsah (2021), preservice teachers' readiness for emergency remote teaching is high, yet "they recorded low readiness in dimensions of learner control, computer/internet self-efficacy, and online communication self-efficacy" (Dorsah, 2021, p.10); thus it adds that a mentor or a coach is vital in facilitating and guiding the student teacher to shift from uncertainty to a supportive, collaborative, and participatory learning space (Baran and AlZoubi, 2020; Ersin et al., 2020). Baran et al. (2011) found that "increasing teacher presence for monitoring students' learning," "increasing organization in course management," "increasing structure," and "reconstructing student-teacher relationships" are the most prominent sides of pedagogical change when teaching moves from face-to-face to online (p. 5). Similarly, based on recent studies, the following three factors are crucial for effective online teaching: (1) compassionate social interaction, (2) appropriate planning, and (3) pertinent execution (Baran and AlZoubi, 2020; Ogbonnaya et al., 2020; Dorsah, 2021; Hojeij and Baroudi, 2021). Similarly, Hodges et al. (2020) stated that the main factors in distance learning caused by a health emergency appear to be ongoing planning and design of online courses, on-the-spot modifications to in-person courses, and familiarity with new technologies for teaching and learning (Sepulveda-Escobar and Morrison, 2020).

Salmon (2000) developed a five-stage model detailing the tasks that e-moderators have to walk their students through to improve the quality of the online teaching experience: access and motivation, online socialization, information exchange, knowledge construction,

and development. This learning paradigm moves across preparatory steps through knowledge acquisition and collaborative work where the learners end up responsible for their learning.

This is in line with the literature that emphasizes the constant effort spent on teaching tasks, such as classroom management, monitoring and assessing learner performance, course clarification, and continuity (Baran et al., 2013).

2.2. Classroom management in virtual settings

The tremendous intricacy of teaching is evident to anybody who has ever faced a classroom full of children while bearing the entire weight and duty of directing and motivating their learning. Even though teaching objectives may be pre-planned, the actual process of instructing students to attain those objectives often takes the form of a succession of unpredictable occurrences, which teachers might interpret in a variety of ways. The plan foresees some occurrences, while others come forth as a result of the unexpected. Being aware of these things, how they develop through time, and how they affect learning may be a key element in effective classroom management (Wolff et al., 2020).

In their definition of classroom management and as cited in Korpershoek et al. (2014), Evertson and Weinstein (2006) allude to the steps instructors take to provide a conducive atmosphere for students' academic and social–emotional growth. They list five different kinds of acts. Teachers must (1) cultivate warm, receptive connections with and among students and (2) plan and carry out teaching in ways that maximize students' access to learning in order to achieve a high standard of classroom management.

Classroom management skills are extremely important in achieving efficient classroom instruction and they correlate with students' learning process in the classroom (Marzano et al., 2003). To increase students' success in schools, teachers should acquire classroom management systems to create a learning environment that enhances both the academic skills and social–emotional development of students (Milliken, 2019). Unfortunately, research indicates that most teacher preparation programs spend minimal time on classroom management instruction. It has also been proven that well-managed classrooms lead to students that are engaged and who will attain high achievement (Milliken, 2019).

Because of all the abovementioned changes in this decade, computer-assisted language learning (CALL) has become a central aspect of teacher training since preservice teachers need to learn how to plan an online course, how to implement online methodologies and teaching techniques coherently with learners' needs, and how to manage a live online classroom (Samu, 2020). Utilizing CALL software is crucial because it makes it possible to promote critical thinking, self-access, and communication in the target language. CALL assumes interactive communication in which exercises are immediately corrected to allow the student to move on to other tasks, or if the answer is incorrect, the student should be given the appropriate feedback in the form of a rule, an example, a new trial, or the right answer and error explanation. As a result, CALL software might be used as an optional, complimentary component of a distance-learning language course (Seljan et al., 2006; Jarvis and Achilleos, 2013).

Finally, on the importance of classroom management in virtual classrooms, a study by Ersin et al. (2020) showed the four major e-practicum areas that teachers were mainly concerned about (i) the challenges of e-practicum and the unique experience that comes with them, (ii) learning how to overcome online technical problems, (iii) classroom management in a virtual classroom, and (iv) the necessity of such an experience for their future career.

2.3. Challenges

Relationships are the core of successful teaching and learning. Teaching and learning occur with the interaction between teachers and students, and in the case of student teachers, with other members of the school community as well (Sepulveda-Escobar and Morrison, 2020). However, one of the difficulties with online learning that was cited by both teachers and students was the limited options for interaction (Hebebci et al., 2020). This was also shown by Samu (2020), who stated that the lack of physical interaction with students, as well as the potential issues that are associated with managing the affective component of these interactions, is one of the major challenges faced by preservice teachers (Samu, 2020). Similarly, Sepulveda-Escobar and Morrison (2020) declared that preservice instructors reported feeling very anxious and having less willingness to teach due to the absence of direct engagement with students. It also made it difficult for them to prepare and alter lesson plans, and they were unable to put the classroom management techniques they had learned during their teaching preparation program to use. In addition, the study by Scull et al. (2020) reported that many preservice instructors allegedly suffered from the absence of actual classroom instruction, with them mostly complaining about the lack of behavioral problems that would occur in actual classroom settings, which prevented them from putting theory into practice, particularly their classroom management techniques.

In addition, Rosilawati (2013) claimed that it could be difficult for preservice teachers to manage discipline-related problems at the beginning of their work experience, particularly during the lessons as they must ensure that students are engaged in learning at the same time (Rosilawati, 2013). Generally, novice teachers feel unprepared to establish a structured classroom environment, engage students in learning, and deal with challenging behavior. Thus, it is very clear that classroom management issues are a serious challenge for novice teachers; disorderly learning spaces, disrespectful interactions, and disruptive student behavior lead to chaos—ultimately draining instructional time (Milliken, 2019). As a result, effective classroom management training is required for teachers to cope with everyday obstacles, especially because many starting teachers join the field of education lacking the abilities required to develop an effective classroom management plan and respond correctly to student conduct. Inadequate and ineffective preservice teacher education has been criticized for new teachers' lack of classroom management competency (Milliken, 2019).

2.4. Strategies

The current pandemic forced educators to move the traditional and mostly comfortable face-to-face setting to a virtual setting without prior preparation. Thus, if preservice teachers are not familiar with and

competent in virtual teaching, they will fail as teachers, so it is crucial to generate suitable strategies for making online teaching successful. A more collaborative and sustainable approach of cooperation between schools and universities that creates and develops suitable strategies to carry out online teaching during a health emergency would surely strengthen the education of both preservice teachers and their learners (Sepulveda-Escobar and Morrison, 2020). Preservice teachers have to learn how to adapt to unexpected situations, how to work with different digital platforms, and how to design strategies to try and reach their students without actually seeing them. Hence, teacher education programs have a significant role in providing opportunities to build a continuum of teacher–pupil encounters to help future teachers become aware of emergent classroom strategies (Sepulveda-Escobar and Morrison, 2020).

The development of student teachers' teaching competency and abilities places high importance on the practical portion of teacher education. They have the chance to refine their teaching skills *via* this practical experience. Students who are also teaching cherish this opportunity to put theory into practice. Consequently, it is here that classroom management is learned (Sepulveda-Escobar and Morrison, 2020). Nevertheless, due to poor classroom management, some teachers fail to deliver their classes as intended despite possessing in-depth topic knowledge. Because of this, teachers need to possess the following three fundamental abilities: prepositional knowledge, procedural knowledge, and conditional knowledge. Prepositional knowledge is the understanding of principles for efficient classroom management. Procedural knowledge is the application of classroom management knowledge by instructors. Conditional knowledge is the understanding of conditions.

Furthermore, it is obvious that preservice teachers must be emotionally and physically prepared for their practicum sessions. They must provide engaging activities in order to engage students, be personable, and learn the names of the students. They should also practice methods for "punishing" inappropriate behavior and rewarding or promoting appropriate behavior (Milliken, 2019). Therefore, effective teachers should employ a range of strategies for various types of students. Conversely, unsuccessful teachers use the same techniques with each and every pupil. Student involvement in the classroom may thus be increased by effective classroom managers.

Samu (2020) stated that increasing teacher–student and student–student interaction during an online course is another helpful strategy that delivers a learning experience similar to face-to-face instruction (Samu, 2020). As a result, preservice teachers must be taught how to organize and manage activities that engage participants in continuing discourse (Samu, 2020). Good lesson preparation, understanding how to include students, and knowing how to ask questions that encourage involvement are all essential components of effective classroom management. A teacher should be able to keep students interested throughout online lessons, avoid daydreaming, and manage students' attention spans because poor classroom management can interfere with the flow of any instruction (Ersin et al., 2020).

2.5. Best practices

The term "best practice" is not agreed upon by everybody. However, according to the United Nations Educational, Scientific, and Cultural Organization (UNESCO), best practices share four traits: they are innovative, make a difference, have a lasting impact, and have

the potential to be replicated and used as a model for launching initiatives elsewhere. A best practice must guarantee the delivery of the greatest favorable result when used to treat a specific ailment, and it must be based on repeatable steps or activities that have been successfully used by many individuals over time (Baghdadi, 2011).

According to Milliken (2019), gaining self-efficacy enhances the teaching and learning process and boosts work satisfaction, all of which will ultimately lead to higher student outcomes. Preservice instructors must, therefore, take charge of the classroom environment by fostering student motivation and ensuring their comprehension, attention span, and desire to study. A recent review identified clear, consistent expectations for students, effective behavior corrections, and positive teacher–student relationships as the three most successful methods for research-based classroom management. Hojeij and Baroudi (2021) mentioned that teachers should put engagement first while instructing online and they can do so by keeping an eye out for both the students who are speaking out at the same time and the more reticent speakers who could be more easily missed. Therefore, before going on to the next topic, teachers should pause and ask if anyone has any more views on the topic being discussed. Teachers may also invite outside speakers who are authorities in related subjects to participate in the class. This will encourage zeal, inspiration, inclusivity, and involvement. A requirement for participation in the classroom community is asking students to switch on their webcams.

If, however, some students feel uncomfortable sharing their living/studying circumstances, teachers should remind students to use virtual backgrounds that can help protect privacy, improve equity, and reduce visual distractions. Teachers should also encourage students to stretch for 30 s every 20 min or so. Furthermore, teachers should encourage students to raise their hands or ask questions throughout the class by urging them to use the discussion features. Furthermore, by using the whiteboard capability to digitally annotate, teachers and students may brainstorm and solve problems together. Like in conventional classrooms, teachers are permitted to make a cold call to a student rather than waiting for them to raise their hands. Finally, studying from home presents difficulties for learner engagement given that children have short attention spans. Therefore, relying on active learning, presenting lessons in bite-sized portions rather than lengthy lectures, and using technology-based teaching strategies, including tools such as mixed media, gamified components, video clips, surveys, and so on, are the ideal options in this case.

2.6. Research questions

1. What challenges did preservice teachers face with their classroom management in virtual settings during COVID-19?
2. What are preservice teachers' perceptions about the successes of their classroom management in virtual settings during COVID-19?

3. Methodology

3.1. Research design

According to Creswell (2013), a case study design involves participants depicting their experiences. The researcher's role is to describe the recurring patterns and themes. The main point of the

research is to understand how people lived through the experience from their own perspective by joining the inner world of each participant (Christensen et al., 2014). Hence, a qualitative approach was adopted to explore the lived experiences of preservice teachers in terms of classroom management in a virtual setting due to COVID-19.

3.2. Context

This research was conducted at an Early Childhood Education Program at the College of Education in a public university in the United Arab Emirates (UAE). This program requires preservice teachers to complete four field experience placements during their course of study. The preservice teachers are placed in an early childhood education setting, usually between grades 1 and 3. The last placement is a full-semester internship spanning 15 weeks of full school instruction and an intervention action research component.

This study was conducted during the internship field experience placement which took place in Spring 2021 over a period of 15 weeks. The preservice teachers were placed in a public elementary school in different grade levels and with different teacher mentors. They had 15 consecutive weeks of full teaching under the guidance of their mentor teachers. In the UAE, public schools opted to use Microsoft Teams for their virtual teaching platform. The preservice teachers were all accustomed to Microsoft Teams and its capabilities as they had used it in their previous field experience placements.

The preservice teachers were given the curriculum plan of the class and had to follow it with the help of their mentors. The mentor teachers were always present in the virtual classroom with no exceptions. Daily lessons were all synchronous.

3.3. Participants

The participants were 18 Emirati female preservice teachers who were attending their final semester internship field experience placement in the teacher preparation program. All student teachers were teaching online full-time, at the same time, as a part of their internship placement. Participants were all "bilingual speakers of Arabic and English," and Arabic was their first language. They were all enrolled in the Early Childhood Education program at the College of Education in a public university in the UAE. Their ages ranged between 18 and 21 years.

The researcher followed a convenience sampling method to select the participants. The participants were chosen from one class because they were one of the first groups to make it to the full 15 weeks of teaching virtually. They were chosen for ease of access to data collection, as well as their longer experience than other preservice teachers in the program. These participants had spent their first field experience in a face-to-face setting and as such could compare the two methods of teaching and learning, especially in terms of classroom management.

3.4. Data collection

The data were collected through semi-structured interviews based on open-ended questions to allow participants to describe and elaborate on their classroom management experiences during their virtual internship. The interview instrument was designed by the researcher based on the literature and consisted of 12 open-ended questions. Participants were asked about their virtual classroom management practices during COVID-19, focusing on skills, strategies, challenges, strengths, and weaknesses. Each interview lasted for an average of 30–45 min.

After obtaining ethical clearance approval from Zayed University Ethical Clearance Committee (ZU20_125_E), participants were invited *via* email for their participation and consent. Participants read and signed the informed consent documents before the interviews. In addition, at the onset of the recorded interview, verbal consent was again obtained, and anonymity was guaranteed. They were also assured that participation had absolutely no influence on their grades and that participation in the study was voluntary and there were no influences on the teacher training course.

The interviews were conducted in English and recorded through the Zoom platform. Recordings were saved on the main researcher's password-protected cloud account. The collected data and its interpretation were conveyed to the participants to ensure credibility.

3.5. Data analysis

The data collected from the semi-structured interviews were manually transcribed and coded by the first author following a thematic analysis approach. No digital tools were used.

Creswell (2008) explained that thematic analysis is when the researcher reads through the data many times to have a full understanding of the phenomenon in order to divide each text into segments of information and then code them as a way to indicate patterns and meaning. The main researcher and one of the co-authors were involved in the coding process to ensure a credible and reliable analysis. The two coders approached the data with preconceived categories (i.e., challenges, strategies, strengths, and weaknesses), and began analyzing the data by coding text units according to what they expected to find. However, they kept the coding open for any emergent or unexpected themes. The coders met several times to compare the codes, merge the ones that overlapped, and reach an agreement on the main and emergent themes. As a result, a total of three themes and six sub-themes were identified.

4. Results

A case study approach was adopted where participants described their experiences, specifically related to their classroom management during their virtual teaching experience during the COVID-19 pandemic. The findings of the study are divided into three main themes and six sub-themes which align with the three research questions, as seen in Table 1 below.

4.1. Theme 1: Challenges of Classroom Management

Based on participants' interviews, there were many challenges during the virtual teaching experience, especially in terms of classroom management. These obstacles are presented below under

TABLE 1 Thematic analysis of data.

#	Theme	Sub-theme	Code
1	Challenges of Classroom Management	Digital literacy	Not ready for online teaching
			Trained for in-person teaching
			Not familiar with online tools
		Online Tools	Variety of online tools
			Variety of apps
			Time management issues
		Online Teaching Platform	Microsoft Teams is not familiar
			Prefer Zoom
			Students in class used Teams mischievously
		Time Management	Managing online classes difficulties
			Managing Activities
			Unexpected disruptions from technology
			Unexpected disruptions from students
			Classroom habits and routines
		Cultural Barriers	Female nationals
			No cameras
			Teaching blind
		Student Engagement	No motivation from students
			No personal connections/rapport
			Very weak interaction
2	Strengths of Online Teaching	Strategies	In-person classroom management
			Online classroom management
		Planning	Planning for online lessons vs. in-person
			Mentor support
			Short lesson plans
3	Overall Experience		Overall positive experiences
			Classroom management challenges
			Lessons learned
			Personal preferences

the following sub-themes: digital literacy, time management, cultural barriers, and student engagement.

4.1.1. Digital literacy

The majority of the participants ($n = 16$) indicated that they were not ready to teach online. They had been training for in-person teaching and their skills were not fully developed to equip them to deal with classroom management in the virtual class. Preservice teachers highlighted during their interviews that technology posed a major challenge to their classroom management. They mentioned the difficulties they faced with the online tools used at their schools, e.g., one respondent stated that "We used the many online tools, and this was a problem for me because I had to focus on the lesson, the technology, and the students. This made me nervous because I was not sure of all the apps they used at the school, and I had to use them online now. I could not control my class because I was busy with trying not to make mistakes with the apps." (P3).

Respondents also had concerns regarding the teaching platform adopted by the Ministry of Education for UAE public schools. As one participant noted:

"In the school, they use so many apps in the online class. This is not good for me because I was so worried about the lesson plan and finishing my objectives. At the same time, the tools were so many, and I needed to know them all because the students know how to use them, and if I make a mistake, I lose the class. I had a hard time with managing." (P7).

Another participant noted that:

"Sometimes the students were not ready to join Teams on time. They also were able to mute me and to kick me out of the class. I did not like Teams at all. I think if we used Zoom, it's better." (P2).

4.1.2. Time management

The majority of participants ($n = 15$) had issues with readiness to manage an online class, especially in terms of time management. In particular, participants mentioned their failure in managing the lesson time while they needed to keep track of the activities and control any unexpected disruptions from the technology or students. This has had consequences on their confidence and satisfaction in teaching online, as mentioned below in their comments.

"I could not stay on time! It was so hard for me to manage everything I had to do and worry about the time as well. This was my biggest problem in the online class. Trying to follow the time of the activities on my lesson plan was so hard for me." (P1).

"In the regular class, we set habits and routines that happen at a specific time in the class. For example, when we come into the class face-to-face in the morning, one student writes the date, another takes attendance, and like this, in my virtual class, I could not do this. There was no time at all to do any of the class routines. Because if I did these, I will lose my time and not finish my lesson. Also, the students were not really interested in the class routines." (P15).

"My biggest problem was managing activities and making sure they finish on time. It took me too long to set the expectations and rules of the activities because there were so many disruptions all the time. So much of my time was spent trying to control the disruptions to the lesson. That is why I lost so much time." (P18).

4.1.3. Cultural barriers

In terms of cultural barriers, all participants were well aware of the restrictions they had to abide by as female Emirati nationals themselves. These were expressed in some of their replies below.

"The students do not turn on their cameras, so I do not know what they are doing. I cannot see them, and they cannot see me. It is teaching in the dark. It was hard to teach like that, the class was difficult." (P5).

"In our culture, women cannot be pictured. So, I had to teach with my camera off. Also, the students were the same. They cannot turn on their camera, so we do not see their house or their family. Sometimes, they had a dad or a brother with them to help them and it's not allowed for them to see us or for me to see them. It's not a good way to have a class but this is the Arabic culture, and we cannot change." (P8).

4.1.4. Student engagement

Student engagement posed an additional challenge to the participants. Approximately 88% of replies ($n = 16$) indicated that students were not engaged in the online classroom. They expressed their dissatisfaction with the motivation of the students and how this affected their lessons negatively. Some of the replies are below.

"Relationships with the students are difficult in the online classroom. I could not make a connection with them. We learned we have to establish a connection but in the real classroom, it is easy because we can see them and do things together. In the online class, there are less chances for interaction." (P10).

"The students are not interested and not motivated. They do not like the online class. They are distracted and they keep logging in and out of the class the whole time. There is not so much student engagement. Even when we try to do group work, they are not motivated, and they do not listen to my instructions." (P16).

4.2. Theme 2: strengths of online teaching

The second topic, which emphasized the advantages of online teaching, produced the sub-themes of planning and strategies. The majority of the participants (89%, $n = 16$) stated overall satisfaction with the planning abilities and classroom management techniques they employed. According to participant replies, getting to put the methods they had learned in their preparatory classes into practice was a useful opportunity. Additionally, because the lessons were brief and they had to collaborate with their mentors in order to develop them, planning for the online classroom was a unique experience. However, as can be seen below, responses indicate the overall worth of this.

4.2.1. Strategies

"My class was successful sometimes and other times no. But I practiced some of the strategies for classroom management that we learned in class at the university." (P4).

"The strategies I used to control my class were good. We learned many good ways to run out class in the course at the university and I tried them in my online class. Many worked so I felt good." (P8).

4.2.2. Planning

"Some activities were fun to plan. I did well on my lesson plans, and I was able to do my activities well. After I plan the lesson, I sit with my mentor from school (on Zoom) and she helped me with the lesson plan. I learned a lot about how to teach a class online from her." (P10)

"The online classes were short, like 35 minutes or something like that. They were easy to plan because they were short. I liked the planning of the lessons and l learned how to make a plan for an online class." (P6)

"The online class is very different and the activities we do are also different from the real classroom. It didn't take a long time for me

to learn how to plan for the online class and what activities I can do. I did well in my planning. My mentor teacher always said I did good." (P9)

4.3. Theme 3: overall experience

In general, the preservice teachers had overall positive experiences during their virtual practice teaching placement. However, despite all the positives, there were still many challenges in the online class especially related to classroom management as indicated by 12 of the participants (67%). Some of their comments are below.

"I think teaching online was a good practice for me. COVID gave me something good. If we did not have the pandemic, my practice will only be in person, and I will never learn how to teach online." (P11)

"The online teaching is very different from the teaching in-person. I prefer in-person. But because of COVID, I had no choice. I learned how to plan a lesson for online class. I also learned how to manage my class and deal with kids who disrupt the class. I learned how to teach on Teams. I mean teaching online was a good experience, but I prefer the real classroom of course." (P13)

In contrast, some of the preservice teachers ($n = 6$) did not enjoy the virtual teaching experience. Their opposing comments are as follows.

"I faced many challenges in managing my online class. The kids were never on time, they didn't take the class seriously. They keep going in and out of the class and saying they have connection issues. The big problem for me was the camera. I could not see them or what they are doing. It didn't feel like they were learning anything. It is like the students had more control over the class than the teacher. I didn't like it at all." (P16)

"I do not like teaching online at all. It is much harder than teaching in class. There is a hard time to make the lesson and to manage the kids. They do not pay attention. They do not want to be online." (P15).

5. Discussion

Having strong classroom management skills is the core of an efficient teaching and learning environment as it is directly correlated with students' engagement and learning (Marzano et al., 2003; Milliken, 2019). In online learning, many factors come in place that would impact teachers' abilities to manage an online classroom, such as teachers' implementation of online methodologies that are coherent with learners' needs and students' motivation to learn (Samu, 2020). This study explored the challenges that preservice teachers faced in virtual settings and investigated perceptions about their success in

classroom management. This was important to address due to the seriousness of this issue for novice teachers in particular (Marzano et al., 2003). Similar to Samu (2020), the findings of Dai and Xia (2020) revealed the extent that limited digital literacy can impact teachers' abilities to manage the virtual classroom. Knowing the use of technological resources is a key pillar in the framework for preparing preservice teachers for online teaching (Hojeij and Baroudi, 2021):

1. The findings showed that student engagement posed an additional challenge to 88% of the participants and this result aligns with the studies by Baroudi and Shaya (2022) and Robinson and Hullinger (2008) which stated that engaging students during online instruction is a key concern for researchers and practitioners as it impacts teachers' performance in the virtual classroom, job fulfillment, and satisfaction.

2. Preservice teachers' time management for instructional tasks has been impacted by a lack of digital literacy. According to Dai and Xia (2020), it is critical to train instructors on how to use digital platforms in order to boost their confidence in planning online education and keeping track of class time. However, the findings of this study show that this has yet to be implemented. Furthermore, the findings revealed that preservice teachers struggled with the internet resources that their schools used.

3. Limited knowledge in using the technology has negatively impacted participants' self-confidence and satisfaction in online teaching as they felt that they were incapable to teach online. Teachers' satisfaction with online teaching has been recently investigated as it is related to their self-efficacy levels (Baroudi et al., 2022). The recent pandemic and the consequences it has had on the education sector opened the eyes of policymakers and school leaders to the importance of increasing educators' ability to perform their job even during the most challenging situations, in other terms, self-efficacy. Hence, if teachers were prepared to use the technology, they would perform better under unexpected situations (i.e., internet disruptions), which would elevate their satisfaction and performance (Bandura, 1994).

An important finding here highlights that for novice teachers as for their more experienced counterparts, the online learning environment hindered their capacities to promote students' social and emotional development. This is also another reason why preservice teachers expressed their discontent about managing the online classroom (Sepulveda-Escobar and Morrison, 2020). It is also important to include the affective aspect of learning within teachers' teaching practices, which is integrated into teachers' interactions and practices inside the class when teachers, for instance, encourage and motivate students, ask about their feelings and concerns, and relate relevant personal experiences (Samu, 2020). As such, to enhance novice teachers' classroom management skills, teaching preparation programs must equip them with teaching practices that would promote emotional development among students due to its short- and long-term benefits toward their engagement, sense of belonging, and overall performance (Milliken, 2019).

On another note, increasing students' social development by building positive teacher–student and student–student relationships in the online classroom is another path to nurturing positive emotions and reducing disruptive behaviors. Sadly, the results of this study showed

that preservice teachers struggled in managing the classroom mainly due to disruptive students' behaviors and because they were "teaching in the dark" as described by one participant. Turning off the cameras for both the instructor and the students for the duration of the course was a major disadvantage that hampered preservice teachers' skills to properly manage the online classroom since they could not interact with the students or create strong connections with them. This issue increased students' disobedience and disturbances, causing instructors psychological discomfort through the negative sentiments expressed in participants' responses, which are thought to have influenced their own ideas and beliefs about teaching in general (Paramita et al., 2020).

Despite these hurdles, online teaching was a positive learning opportunity for preservice teachers as it trained them to work under pressure and find immediate solutions to disruptions that threatened their classroom management abilities. It prepared them to become more adaptable and flexible, take risks, make decisions, and learn from their mistakes. All of which are skills needed to increase their resiliency and self-efficacy levels so they can sustain their performance in unexpected situations.

The study's main finding, in summary, was that preservice teachers had pedagogical, technical, and social–emotional issues that overshadowed their potential. One of these was maintaining an interesting virtual classroom for the students. This study also demonstrated that successful online course management and teaching depend on participants receiving adequate and pertinent training and information about developing purposeful asynchronous learning resources, technology pedagogical understanding, and obligations related to the roles they will play in online learning.

6. Conclusion

The purpose of this study was to explore the experiences of Emirati female preservice teachers who were completing their internship teaching practice virtually due to the COVID-19 pandemic. The study's findings show that, despite the difficulties they faced, most preservice teachers (67%) were able to effectively operate and deliver online classes. Their triumphs and possibilities greatly surpassed whatever difficulties they faced. Moreover, the study's findings revealed that preservice teachers benefited from the global COVID-19 epidemic because it sparked their interest in online education and gave them the skills they needed for blended learning, which is now widely used. However, it was considered disappointing that the education system suffered unspeakable losses that decreased the likelihood of achieving the fourth sustainable development goal, and children with special needs took the brunt of the rapid change in curriculum. Despite this, it is important to note that effective teaching and classroom management is possible in a setting where inexperienced teachers are fully supported and motivated by their school mentors and university supervisors to perform at their best.

7. Implications, recommendations, and limitations

Although this study focused on the time when COVID-19 was at its peak, when many countries were under lockdown, the results of the research have implications for current teaching and learning. The study implies that teacher training institutions must step up their efforts to promote blended learning with more focus on online

learning. This will prepare preservice teachers so that they gain comprehensive knowledge, pedagogical skills, and technological skills to be able to teach effectively when they graduate. Training students on using technological tools and pedagogical skills play a significant role in teachers as it improves their self-efficacy beliefs in online teaching (Baroudi and Shaya, 2020).

It is recommended that trainee teacher institutions reconsider their curricula to make sure that they include technological literacy, allowing students to graduate with significant knowledge about online and blended teaching. Institutions must strive to ensure that the curricula sufficiently cover all the 4Cs (critical thinking, collaboration, creativity, and communication) of the 21st century.

The study was limited to a federal institution in the UAE where students were only women. That was the first limitation. The second limitation is that researchers did not collect data regarding preservice teachers' abilities to create authentic learning opportunities or collaborative learning opportunities as these are key to ensuring a positive learning environment and successful classroom management.

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 Zayed University Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ZH, SB, and LM contributed to the writing of this manuscript. ZH took the lead in the project and completed the literature review, data collection, data analysis, results, and revised and edited the manuscript. SB completed the revision of the literature review and the methodology section. LM completed the third review of the literature review and the discussion draft. All authors contributed to the article and approved the submitted version.

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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Shall we play together? Game-based learning for engagement and classroom climate in Spanish socially deprived communities

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Purpose: The purpose of this study is to analyze the effects of a game-based learning (GBL) program on the classroom climate and engagement of high schools in socially deprived communities in Spain.

Methods: The study included 277 students from two secondary schools located in Southern Spain, situated in Zones in Need of Social Transformation. Sampling was non-probabilistic and accidental, based on the accessibility of the school and the willingness of the management and teaching staff to participate in the GBL program. The study employed a control group and two experimental groups (cooperative games group only and cooperative and competitive games group) to compare pre-test and post-test data in both groups. The Brief Class Climate Scale and Engagement Inventory, validated in academic literature, were used as assessment instruments.

Results: The study used a series of ANOVA tests to compare the experimental groups with the control group. The results indicated statistically significant changes in all study variables. In all cases, the experimental groups demonstrated greater benefits than the control group.

Discussion and conclusion: The study findings reveal that games can provide significant benefits to students, regardless of whether they are cooperative or competitive. The study provides evidence of the benefits of GBL in high schools located in socially deprived communities in Spain.

KEYWORDS

game-based learning, games, engagement, classroom climate, high school, teenagers

1. Introduction

1.1. Classroom climate in socially deprived communities

Classroom climate refers to the perceptions and opinions of students and teachers about the educational environment within the classroom (Villanueva, 2020). During adolescence, classroom climate is especially critical as it is a crucial stage in emotional development and where students spend most of their time socializing in school (Wang and Eccles, 2012).

A positive classroom climate is characterized by respectful and emotionally supportive relationships between teachers and students. In contrast, a hostile classroom climate implies a lack of emotional connections between teachers and students, which can encourage disrespect, insults, and even aggression (Cohen, 2021), leading to academic demotivation and emotional disconnection with education (Sakiz, 2012). Extensive research has been conducted on the relationship between teachers and students, concluding that teachers should be emotionally competent and offer sympathetic treatment to students to help them feel respected in the classroom (Brackett, 2019; García-Moya et al., 2020). They should also create motivating learning situations that can promote positive feelings toward learning (LeBlanc, 2022). In the meta-analysis study by Wang et al. (2020), it is evident that classroom climate has a positive relationship with social competencies, motivation, engagement, and academic performance while damaging relationships with socioemotional distress and antisocial behaviors.

In Spain, Decree-Law 7/2013, of 30 April 2013, on extraordinary and urgent measures for the fight against poverty and social exclusion (BOJA no. 85 of 03/05/2013) defines Zones in Need of Social Transformation (ZNTS) as specific and physically delimited urban spaces where the population experiences severe poverty and social marginalization. Socioeconomic difficulties, such as deterioration or deficits of infrastructures and public services, high unemployment rates, hygienic-sanitary deficiencies, and low parental education, can manifest in these areas, leading to an inability to accompany students to school. This can also result in socio-educational difficulties related to social exclusion, high absenteeism rates, and school failure (Fernández-García et al., 2019).

Children and teenagers socialized in ZNTS, socially deprived communities, may exhibit antisocial and violent behavior patterns that directly affect the classroom climate and negatively manage classroom conflicts (Narváez Burbano et al., 2020). Therefore, their education requires a set of general and specific measures and resources to facilitate flexible groupings, preventive programs, open and flexible organization of spaces and times, an adaptation of didactic programs, and educational reinforcement to compensate for possible family, economic, and sociocultural deficiencies and reinforce the learning of basic skills (Ruiz-Román et al., 2019). Creating and strengthening peer relationships have been critical in generating a positive classroom climate (Urdan and Schoenfelder, 2006; Okada, 2021). To achieve this support, teachers should create learning situations that allow peer relationships and cooperation (Cecchini Estrada et al., 2019).

1.2. Engagement and academic motivation

Engagement in education refers to the degree to which students are immersed in classroom activities (Clynes et al., 2020). The more engaged the students are, the more focused and participative they are likely to be in the task (Bergdahl et al., 2020; Xie et al., 2020). Engagement is influenced by various factors, including teaching style, sociocultural context, and motivation toward the task (Kahu et al., 2020). Behaviors related to student engagement are dynamic and interconnected with the environment. In socially deprived communities, students often exhibit lower academic motivation and low expectations regarding their abilities, leading to academic demotivation, absenteeism, and school failure (Ricard and Pelletier, 2016; Artuch-Garde et al., 2017). Engagement is associated with positive emotions that enable student participation (Shelton-Strong and Mynard, 2021). High engagement leads to positive changes in behavior and represents a proactive attitude toward learning, leading to reduced school dropouts (Marôco et al., 2020; Abreu Alves et al., 2022).

Engagement comprises three interrelated dimensions: emotion or affect, behavioral aspect, and cognitive aspect (Christenson et al., 2012). Emotion refers to the positive emotions experienced and the absence of negative emotions in the environment, which encourages the student to continue in that situation (Skinner et al., 2008). The behavioral aspect refers to all the energy mobilized to satisfy expectations related or unrelated to learning, which is associated with the social and cultural context (Medrano et al., 2015). Finally, the cognitive aspect refers to the cognitive strategies that the learner performs to achieve the set goals (Galikyan and Admiraal, 2019). Engagement is closely related to motivation, and intrinsic motivation is a prerequisite for engagement to occur (Delaney and Royal, 2017). Engagement protects against school dropouts (Álvarez-Pérez et al., 2021) and is positively associated with school performance (Estévez et al., 2021) and socioemotional wellbeing (Wang et al., 2019). Intrinsic motivation and actual engagement positively correlate and influence learning outcomes (Saeed and Zyngier, 2012). Teachers should use educational strategies that promote motivation and meaningful learning to enhance engagement and prevent student disengagement (Balwant, 2018; Lira Munizaga and Pérez-Salas, 2022).

Students in ZNTS are at a higher risk of failing to complete their studies successfully (Rydell, 2010) and exhibit lower motivation and academic achievement (Leggett and Harrington, 2021). Therefore, measures and resources should be put in place to support these students, such as flexible groupings, preventive programs, an adaptation of didactic programs, and educational reinforcement to compensate for possible family, economic, and sociocultural deficiencies and reinforce the learning of basic skills (Ruiz-Román et al., 2019). Engagement can help students overcome these challenges and succeed in their academic pursuits.

1.3. Game-based learning

Games have the potential to facilitate cognitive and behavioral changes and can be used as learning resources (Buelow et al., 2015; Krath et al., 2021). Playful activities are associated with the need for expression and the search for gratifying emotions, and this dimension of human development is known as the playful universe, or homo ludens (Bayeck, 2020). Games are cultural phenomena that can provide rewarding learning experiences. The educational field has shown interest in exploring games and playful strategies as innovative learning spaces (Wu et al., 2012; Manzano-León et al., 2021a,b) to promote esthetic experiences of enjoyment and generate differences from traditional didactic materials that only focus on content (Barría, 2022).

Game-based learning (GBL) is the systematic use of analog or digital games to work on specific contents or skills previously established by the teacher (Cornellà et al., 2020). GBL can be used in education through two channels: a rational and analytical channel that highlights its formal structure formed by rules, mechanics, dynamics, and procedures, and an emotional and experiential channel that highlights those elements that motivate players, such as fun, competition, cooperation, or challenges (Olejniczak et al., 2020).

Although GBL has shown many possibilities and benefits, potential limitations have also been noted, such as the negative perception of play by families and even teachers as a distraction to learning (Kirstavridou et al., 2020) and the discomfort and stress that game competition can cause for some students (Jääska and Aaltonen, 2022). Students may also prefer traditional learning methods due to the difficulty and demand of gamified lessons (Scepanovic et al., 2015).

Learning is linked to play through motivation as playing is enjoyable for humans and can serve as an engine for learning different contents, values, and competencies. Playful learning is theorized to foster greater motivation and fun while working on concepts, skills, and behaviors (Fulya Eyupoglu and Nietfeld, 2019). GBL aims to achieve greater motivation and fun while working on these same concepts, skills, and behaviors. Recent research has highlighted the simplicity of GBL's mechanics and game dynamics, as well as its affordability and accessibility, which favor its use in both formal education and informal learning environments (Wonica, 2017).

At a conceptual level, GBL can be a refreshing approach to learning in secondary education, fostering knowledge construction while encouraging creativity and imagination. Play involves learning as participants engage with play and learn to interact with play (Steinkuehler et al., 2012). GBL can also support constructivist learning, where learning is embedded in participation, engagement, and interaction with and around games (Gee, 2005). Learning occurs not only through knowledge acquisition or behavioral change but also in the various practices and interactions that players engage in within the play experience (Ke et al., 2016).

1.4. Research objectives

This study focuses on the effects of a GBL program on the classroom climate and engagement of high school students in socially deprived communities. It is a longitudinal quasi-experimental study (pre-post-test) conducted among Spanish high school students. The program designed and evaluated a board game initiative during a 12-week tutoring period to promote positive coexistence. While there is evidence of a positive relationship between games and classroom climate (Huizenga et al., 2019; Coleman and Money, 2020), gamification on engagement and flow (Manzano-León et al., 2023) has been studied, and the application of GBL to the study of classroom climate with socially deprived communities is underexplored. This study aims to address the following research questions:

- Does the GBL influence the student's perception of the classroom climate?

TABLE 1   Study participants.

	Sex		Age		Total N
	Men	Female	M	DT	
Control	57	54	13.49	1.48	111
Experimental 1 (cooperative games)	38	34	14.66	1.46	72
Experimental 2 (cooperative and competitive games)	49	45	14.79	1.47	94
Total	144	133	13.55	1.47	277

- Does the implementation of GBL have any impact on student engagement?
- Does selecting games [cooperative only or mixed (cooperative and competitive)] influence school climate and engagement?

2. Materials and methods

2.1. Participants

The selected sample for this study consisted of high school students from nine classes located in the southern region of Spain within ZNTS. Randomization was used to determine which classes would participate in the control group and which classes would be assigned to the experimental group. The sample size and distribution are shown in Table 1.

The sample was non-probabilistic and selected based on the accessibility of the schools and the willingness of the management and teaching staff to participate in the GBL initiative. To be eligible for either the experimental or control group, students had to meet the following criteria: students should (a) be enrolled in ZNTS; (b) be between the ages of 13 and 16 years; and (c) have attended at least 60% of the tutoring classes during the period being evaluated.

Before data collection, the students were fully informed about the nature of the research and were assured of anonymity. The GBL program was integrated into the tutoring curriculum. This study adhered to the recommendations of the American Psychological Association and the Declaration of Helsinki, and ethical approval was obtained from the Research Ethics Committee of the University of Almería (ref. 01/2021).

2.2. Instruments

The Brief Classroom Climate Scale (Bisquerra and López-Gonzalez, 2013) is a questionnaire consisting of 11 items, which are divided into two dimensions (Group cohesion and Group leadership) and five subdimensions (satisfaction and involvement, peer cohesion, teacher–student relationship, order and organization, and task orientation). The items are classified on a four-point Likert scale, which presents four response options: never, sometimes, frequently, and always. The total scale has a high internal consistency, with a Cronbach's alpha value of 0.83.

The Engagement Inventory (Wang et al., 2014) is a questionnaire that has been validated for use with Spanish-speaking populations through a confirmatory factor analysis (Manzano-León et al., 2021a,b). The questionnaire assesses students' engagement and consists of items that measure behavioral, cognitive, and emotional engagement. The internal consistency of the questionnaire is high, with Cronbach's alpha values exceeding 0.80.

2.3. Procedure

To address the research questions, a quasi-experimental longitudinal design with pre-post-evaluation and a control group was conducted. Before the intervention, a preliminary assessment was carried out to ensure equivalence between the groups on the variables under study. The experimental group received 12 sessions of a GBL workshop in the tutoring subject of the 1st and 2nd years of high school, while the control group watched videos related to tutoring, completed reading assignments, and did homework on other subjects during tutoring classes. After the intervention, the same questionnaires were administered during school hours. It was agreed with the participating schools that if the GBL program was beneficial for the students, the control group classes would participate in the following school year.

For the GBL workshop, commercial board games that could effectively enhance classroom climate and student engagement in the tutoring class were selected by researchers who specialized in ludic strategies. The GBL program was designed using competitive and cooperative dynamics in the chosen games. Competitive games have traditionally been used to create an enjoyable experience for players, allowing them to stay interested in the activity for longer (Camacho-Sánchez et al., 2023), which can increase motivation and participation. However, using only competitive dynamics can create a tense and even violent atmosphere (Adachi and Willoughby, 2011). On the other hand, cooperative games can promote relationships between participants and allow for more social interaction, encouraging socialization and greater understanding between people (Creighton and Szymkowiak, 2014).

The selected games had a variety of game mechanics, dynamics, and esthetically appealing features to young adolescent audiences. The games selected were as follows (see Table 2).

To address the third research question, the experimental group was divided into two subgroups: one played only cooperative games, and the other played all the selected games, both cooperative and competitive. The workshop was conducted during one trimester of the tutoring course, with 12 1-h sessions during school hours. The classroom teacher and two principal investigators jointly conducted the workshop. Before starting the program, the teachers received training on GBL, and the games used in the program.

2.4. Data analysis

The data processing for this research study utilized R Studio software in version 4.01 with the Tidyverse package. To calculate

TABLE 2 Selection of board games.

Name (editorial)	Game type	Components	Game objective
Batalla de genios (Lúdilo)	Competitive	Board and dice	Be the first to place the pieces in an orderly sequence, avoiding the wooden obstacles indicated by the dice.
Camel up (Más que Oca)	Competitive	Dice, cards, and board	Earn as much money as possible by supporting the Camel they believe will win each Stage and the one that will win and lose the entire race.
Días de Radio (Guerra de Mitos)	Cooperative	Cards	Narrate a story in real-time, using ideas from the scripts (letters) provided by their classmates.
Isla prohibida (Devir)	Cooperative	Board and cards	Collect the four treasures on the island without any player being cut off or the tide rising high enough. Players must cooperate to collect the treasures, secure the grounds, and reach the helicopter.
Rhino Hero (Haba)	Competitive	Cards	Build a tower as high as possible, selecting special effects from your cards, such as having another player draw cards, jumping turns, or placing Rhino Hero (a piece of wood) on top of the tower.
Sherlock Q (Guerra de Mitos)	Cooperative	Cards	Solve a mystery from the cards, reviewing important information and solving direct and inferential questions.
Sí Señor Oscuro (Asmodee)	Competitive	Cards	Make excuses with the text or images on the cards and incriminate another player
Speed Cups (Mercurio)	Competitive	Cutlery, cards, and bell	Be the first to arrange the colored cups as indicated on the cards and ring the bell.
Story cubes (Asmodee)	Cooperative	Dice	Tell or write an invented story related to the dice drawings.
Taco, gato, cabra, queso, pizza (Ludilo)	Competitive	Cards	Be the first player to run out of cards. When a player discards a card that matches the word he says, he places his hand on the center pile; the last player to place his hand on the center pile gets all the cards in the pile.
Virus (Tranjis Games)	Competitive	Cards	Get a healthy body (4 organ cards) in your game space. In the game, you can place organs, put viruses on others, cure viruses, or use cards with special effects.

Source: own elaboration.

TABLE 3 Means and standard deviations of the variables studied before and after the intervention.

	Control		Competitive		Competitive-cooperative	
	M	SD	M	SD	M	SD
Pre engagement inventory						
Affective motivation	16.67	3.05	17.49	3.48	17.37	3.23
Motivation behavior	16.00	2.82	16.67	2.82	16.18	2.68
Class participation	16.65	2.97	17.34	2.83	17.32	2.92
Cognitive motivation	33.63	6.76	34.53	6.34	33.74	6.04
Disengagement	6.38	2.39	5.89	2.74	6.10	2.30
Pre-classroom climate						
Satisfaction climate	6.40	1.46	6.30	1.50	6.19	1.59
Cohesion climate	5.94	1.42	5.74	1.27	6.06	1.55
Full cohesion	12.33	2.48	12.04	2.28	12.26	2.70
Relationship climate	5.82	1.27	5.67	1.05	5.65	1.30
Order climate	5.35	1.20	5.36	1.24	5.19	1.07
Orientation climate	7.41	1.68	7.34	1.29	7.26	1.58
Driving climate	18.59	3.43	18.37	2.73	18.10	3.16
Post engagement inventory						
Affective motivation	16.70	2.43	18.87	2.96	19.59	2.35
Motivation behavior	16.47	2.54	17.49	2.39	18.40	2.57
Class participation	17.13	3.01	18.97	3.32	18.69	3.34
Cognitive motivation	34.18	6.79	42.27	7.04	42.76	6.39
Disengagement	5.58	2.15	4.64	1.52	4.43	1.28
Post-classroom climate						
Satisfaction climate	5.92	0.96	7.64	1.04	7.61	1.23
Cohesion climate	6.03	1.23	6.94	1.51	7.04	1.35
Full cohesion	11.96	1.63	14.58	2.08	14.65	2.12
Relationship climate	6.08	0.98	7.36	1.24	6.92	1.25
Order climate	5.76	1.01	6.20	1.20	6.07	1.02
Orientation climate	7.45	1.35	8.50	1.59	8.26	1.49
Driving climate	19.29	2.42	22.08	3.02	21.26	2.75

the direct scores for each factor containing the instruments used in this research, responses from the participants in each group were taken and processed according to the manuals of the instruments.

Before starting the statistical analysis, an ANOVA test was conducted to verify the equivalence of the groups at the start of the investigation, using the pre-test scores. To answer the research questions, another ANOVA test was conducted using the post-test scores of the participants, with *post-hoc* tests conducted after statistically significant differences were determined.

The Bonferroni adjustment method was used for *post-hoc* tests, and ANOVA tests were chosen instead of *t*-tests to avoid type 2 errors. This decision was made due to the sample size potentially causing the accumulation of small differences to be interpreted as statistically significant differences when there may be no meaningful differences.

3. Results

The analysis of the results was guided by the research questions posed in this study. Therefore, this section has been structured according to the research questions. Table 3 reports the means and standard deviations of the control and two experimental groups (cooperative and competitive-cooperative).

The initial comparison between groups was conducted using the pre-intervention scores, and an ANOVA test was performed for each study variable. The results of the analysis are presented in Table 4. The statistical tests showed no statistically significant differences ($p < 0.05$) between the groups for any of the variables analyzed. Therefore, it can be concluded that the groups started from a statistically equal baseline in the variables analyzed in this research.

TABLE 4 ANOVA tests of variables on scores before intervention.

	F	p	η_p^2
Pre engagement inventory			
Affective motivation	2.883	0.091	0.01
Motivation behavior	0.293	0.589	0.001
Class participation	3.181	0.76	0.011
Cognitive motivation	0.129	0.72	<0.001
Disengagement	0.686	0.408	0.002
Pre-classroom climate			
Satisfaction climate	0.617	0.85	0.003
Cohesion climate	0.411	0.522	0.001
Full cohesion	0.036	0.849	<0.001
Relationship climate	0.732	0.849	<0.001
Order climate	0.799	0.372	0.003
Orientation climate	0.308	0.579	0.001
Driving climate	0.873	0.351	0.003

TABLE 5 ANOVA and *post-hoc* tests for scores after intervention.

	F	p	η_p^2	Post-hoc
Post-engagement inventory				
Affective motivation	67.71	***	0.197	Control-Exp1***/Exp1-Exp2***
Motivation behavior	28.08	***	0.092	Control-Exp1***/Exp1-Exp2 = 0.03
Class participation	12.75	***	0.044	Control-Exp1***/Control-Exp2***
Cognitive motivation	80.09	***	0.225	Control-Exp1***/Control-Exp2***
Disengagement	5.365	***	0.069	Control-Exp1**/Control-Exp2***
Post-classroom climate				
Satisfaction climate	112.47	***	0.29	Control-Exp1***/Control-Exp2***
Cohesion climate	26.23	***	0.087	Control-Exp1***/Control-Exp2***
Full cohesion	90.18	***	0.246	Control-Exp1***/Control-Exp2***
Relationship climate	24.83	***	0.083	Control-Exp1***/Control-Exp2***
Order climate	4.32	0.03	0.015	Control-Exp1*
Orientation climate	14.19	***	0.049	Control-Exp1***/Control-Exp2***
Driving climate	24.36	***	0.081	Control-Exp1***/Control-Exp2***

*$p < 0.5$; **$p < 0.01$; ***$p < 0.001$; Control, control group; Exp1, group cooperative games; Exp2, cooperative and competitive group games.

The analysis of the first research question regarding the students' perception of classroom climate shows that ANOVA tests performed with the scores obtained after the intervention was completed yielded statistically significant differences ($p < 0.05$) between the control group and the experimental groups in all study variables. Table 3 demonstrates that these differences were in favor of the experimental groups, indicating that the intervention positively modified the classroom climate perception in the experimental groups. Another way to reinforce this statement is to observe the effect sizes found in the statistical analysis, reported by partial eta squared (η_p^2), which ranged from moderate (0.02–0.09) to strong sizes (>0.09).

The analysis of the first research question regarding the students' perception of classroom climate shows that ANOVA tests performed with the scores obtained after the intervention was completed yielded statistically significant differences ($p < 0.05$) between the control group and the experimental groups in all study variables. Table 3 demonstrates that these differences were in favor of the experimental groups, indicating that the intervention positively modified the classroom climate perception in the experimental groups. Another way to reinforce this statement is to observe the effect sizes found in the statistical analysis, reported by partial eta squared (η_p^2), which ranged from moderate (0.02–0.09) to strong sizes (>0.09).

Regarding the second research question, which deals with student engagement, ANOVA tests were also performed with the scores obtained after the intervention, showing statistically significant differences ($p < 0.05$) between the experimental and control groups in the variables studied. *Post-hoc* tests revealed differences in favor of the experimental groups. Effect sizes found varied from moderate to strong, suggesting that the intervention modified student engagement, increasing it in the experimental groups (see Table 5).

Finally, the third research question aimed to explore whether the mechanics used in the experimental groups, one with

only cooperative games and the other mixing competitive and cooperative games, had any effect on the perception of classroom climate and student engagement. To answer this question, *post-hoc* tests were conducted and are shown in Table 5. No statistically significant differences were found when comparing the experimental groups. However, differences were found between the control group and each of the experimental groups. Therefore, it can be deduced that the mechanics used in the groups did not have a statistically significant influence on the variables studied.

4. Discussion and conclusion

The ZNTS faces significant economic and social challenges that require a comprehensive approach to promote sustainable and equitable development (Chapman and Ainscow, 2019; Vela-Jiménez et al., 2022). Providing quality educational opportunities

that give access to students to improve their living conditions and have a promising professional future is one of these challenges. Barriers to delivering such education include limited access to education, inadequate infrastructure, and gender equity issues (Cárdenas-Rodríguez et al., 2018). Additionally, Abuya et al. (2013) identify the general lack of motivation toward school as another obstacle. Therefore, finding educational methodologies and strategies to promote student engagement and motivation in compulsory education is a leading topic in educational research (Rumberger and Rotermund, 2012; Keyes, 2019). Among these methodologies, game-based learning and gamification are increasingly prominent (Abdul Jabbar and Felicia, 2015; Pratama, 2020; Jayawardena et al., 2022). This research aims to integrate a GBL experience to evaluate its impact on the engagement and classroom climate of Spanish high school students in ZNTS.

In response to the first research question (does GBL influence students' perception of the classroom climate?), this study provides new insights into GBL as an effective strategy for improving the classroom climate in ZNTS. The results demonstrate that students who played board games during tutorials experienced statistically significant improvements in all the variables studied. However, it should be noted that some effect sizes were small, which may limit their impact on individuals, such as in the classroom climate and climate orientation within the climate scale, and class participation in the engagement inventory. Despite these limitations, students who played board games during tutorials exhibited improvements in the study variables compared to those who attended regular tutoring sessions. These findings align with previous research reporting the benefits of GBL in the classroom (Pinedo et al., 2022). Therefore, board games can be a valuable resource for students, improving the classroom climate through game mechanics and dynamics that favor cooperation, communication, and conflict resolution, leading to better group dynamics and a more positive and welcoming classroom environment (Smith and Golding, 2018; Bauserman et al., 2021).

After answering the second research question (Does the implementation of GBL impact student engagement?), this study examined GBL as an influential variable in student engagement in ZNTS. The research compared the engagement and disengagement of the three groups (control, experimental group of cooperative board games, and experimental group of competitive and cooperative board games). The results indicate statistically significant improvements in all the variables studied, with the motivation variables of the engagement inventory and the total cohesion of the classroom climate experiencing significant changes. The increase in motivation coincides with the affirmation of board games in the classroom as a motivating activity, as indicated by previous studies (Acquah and Katz, 2020; Teixeira et al., 2022).

Revised: With regard to the comparison between the groups that played competitive games and a mixture of competitive and cooperative games, the study found no statistically significant differences in any of the study variables. This aspect of the study is significant because it explores how the type of game affects social behavior in the classroom, which has yet to be previously investigated.

The focus of this study is to inform the scientific and educational community about the potential of GBL with both cooperative and competitive board games for improving classroom climate and engagement, particularly in ZNTS. However, the main limitation of this research is the sample size of secondary school students, which is limited to a single Spanish city with ZNTS. To further validate the findings, future research should replicate this investigation in other disadvantaged contexts. Additionally, studying the long-term effect (follow-up test) of the use of GBL on the variables studied, as well as the influence of GBL on other variables of interest such as academic performance, emotional intelligence, and school absenteeism, should be considered in future studies. Overall, it can be concluded that GBL can be an innovative and effective educational methodology to promote a positive classroom climate. Board games allow students to interact with each other in a playful environment, which encourages cooperation, communication, and conflict resolution among students, leading to better group dynamics and a more positive and welcoming classroom environment.

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 the Research Ethics Committee of the University of Almería (ref. 01/2021). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

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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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Teachers' views on the effect of STEM education on the labor market

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Introduction: This paper explores teachers' views on the impact of STEM education on the labor market. This study focused on teachers' views to investigate STEM education and the labor market and the relationship between the two.

Methods: The sample consisted of 32 teachers from different branches. Participants were recruited using purposive convenience sampling. This paper adopted a qualitative case study research design. Qualitative data were collected using a semi-structured interview form. The qualitative data were analyzed using inductive content and descriptive analysis.

Results: Participants stated that STEM education offered new fields of work, promoted entrepreneurship, and increased job opportunities. They also noted that STEM education helped reduce social costs. They emphasized that STEM education made participants happy, prevented brain drain, and reduced social problems. On the other hand, they also noted that STEM education could lead to technological unemployment. The descriptive analyses showed that STEM education had a positive impact on employment, a reduction in social costs, and a positive impact on underemployment. In light of the results, we made recommendations for future research.

KEYWORDS

STEM education, labor market, teacher, workforce, technological unemployment

1. Introduction

Technological developments and globalization are changing every aspect of life. Technology impacts all areas, from education to the economy and business to social life. These changes lead to the emergence of new education and production models, social lifestyles, and many other areas that are not listed. Globalization and the new world order are changing the labor market and working life. Introducing new production processes into the labor market is a source of economic efficiency and effectiveness. New or updated production processes also push workers to update or renew themselves. Therefore, globalization and innovation bring about differentiation, updating, and openness to innovation in all areas of life. Therefore, In the new world order, employees must be more technically competent than ever. One of the most important ways to achieve this is for employees to receive training appropriate for emerging technical issues and new business processes. In this regard, educational processes should evolve toward more technical subjects early. STEM education helps students develop technical skills at an early age. STEM education is an educational approach that integrates science, technology,

engineering, and mathematics by making connections to everyday life (Dare et al., 2019).

STEM education combines scientific and theoretical mathematical knowledge with engineering applications, enabling technological products to emerge (Yıldırım, 2021). New technological products mean new job opportunities. For example, software developers became in high demand because IBM computers were introduced to the market in 1956. Today, we witness the emergence of various professions, such as digital content creators, data analysts, virtual reality creators, etc. (Çepni and Ormancı, 2018). Therefore, new generations should adopt technology. This is realized through STEM education (Sudan, 2021). Therefore, individuals with STEM education will have more job opportunities (Andrée and Hansson, 2020) because it will help students acquire knowledge about different areas and equip themselves with 21st-century skills that will get them jobs in different fields. Other issues that are effective in future planning are globalization and technological advancement. Artificial intelligence automation, machine learning, and robotics are critical issues of the near future. These topics also align with STEM education. Soon, STEM education will cause radical changes in the labor market (Camilli and Hira, 2019). Employees will need to receive specific training in order to adapt to these changes. There are different approaches (design-based learning, creative problem-solving methods, and STEM education) to provide the necessary training for the workforce. Of these approaches, STEM education is one of the best options because it helps students come up with creative solutions and designs to different problems in daily life. Different learning methods, such as problem-based learning and project-based learning are included in the process within the scope of STEM education, which allows students to acquire the knowledge and develop the skills necessary for the business world. STEM education has had an impact on the labor market in a number of different areas (Peters and Jandrić, 2019). STEM education transforms students into more skilled employees who are highly sought after in the labor market (Ring et al., 2017) because it helps them acquire a variety of knowledge and develop the 21st-century skills necessary for the business world. In other words, STEM education increases the number of employment positions for a qualified workforce (Çepni and Ormancı, 2018). Therefore, industries use STEM education to search for and train qualified people for the workforce (Andrée and Hansson, 2020). STEM education prepares the younger generation for challenges (Nguyen et al., 2020). Moreover, STEM education and workforce reform are policies that address labor market failures (Grigorescu et al., 2020). In fact, countries are preparing development plans to address this and increase the number of STEM graduates, because increasing the number of STEM graduates will increase the number of people working in STEM fields.

Research shows that more STEM graduates mean more economic growth and employment (Bacovic et al., 2022). Therefore, people with STEM education are more likely to find jobs. Research even shows that unemployment rates are lower among STEM education graduates (Langdon et al., 2011). People who receive STEM education also develop entrepreneurial aspects and perspectives (Bekki et al., 2018). STEM education positively affects entrepreneurial behaviors (Yaki et al., 2021). In other words, STEM education leads to positive changes for both on the side of employers and on the side of workers.

Moreover, STEM education has much heterogeneity regarding the type and nature of jobs in the labor market. Although each job has different requirements and qualifications, it can be related to STEM education (Salzman and Benderly, 2019, p. 12). This is due to the multidimensional nature of STEM education (Yıldırım et al., 2022). This feature makes STEM education more dynamic, especially regarding the labor market and employment.

1.1. Research purpose and significance

Unemployment is a global problem. Especially in developing countries, youth unemployment is high due to a lack of demographic balance (Buheji, 2019). Unemployment will continue to be a macroeconomic problem for nations with varying levels of development, inequitable income distribution, and demographic disparities. Therefore, economic or non-economic policies to reduce unemployment rates will remain important for a long time.

Labor market mobility is reduced by excessive vocational education. People with STEM education do not need job mobility because they are qualified (Yang, 2018). Therefore, unemployment is also prevented by well-designed and planned STEM education programs. Thanks to STEM education, both workers will not be unemployed, and the unemployed will be more likely to find jobs as they will be better able to meet the requirements of vacant job positions. Many researchers emphasize that STEM graduates will have many job options in the future (Çepni and Ormancı, 2018; Yang, 2018; Bacovic et al., 2022). Therefore, from preschool to higher education, STEM education is implemented in formal or informal educational environments (Yıldırım, 2020). Higher education institutions, in particular, are highly involved in STEM education because they profoundly impact regional innovation and development. From various perspectives, higher education institutions represent high investment intensity. Most of this investment is in STEM-related activities (Noonan et al., 2021). More investment means higher labor demand. In doing so, the relationship between STEM education and the working population is also indirectly realized. Therefore, STEM education impacts many areas of the economy, especially the labor market (Yıldırım et al., 2021). A strong link must be established between the STEM education system and economic life for the former to have a greater impact on the latter. However, STEM education remains underrepresented in early education (Allen, 2016). One way of tackling the issue is by teaching children how to question things.

This makes young people more curious and engaged, improving STEM education quality (Decoito and Myszkal, 2018). Early childhood STEM education has many economic benefits. Therefore, this paper focused on teachers' views on the relationship between STEM education and the labor market. Our results will help us understand how teachers and students perceive STEM education and allow us to make more informed decisions about STEM education content (Arslan, 2021).

In this regard, STEM education has many direct and indirect effects on the labor market (Çepni and Ormancı, 2018). We can better investigate these effects and make more use of STEM education. To this end, the opinions of teachers who have been recipients and providers of STEM education are critical. Few researchers have examined teachers' views on STEM education and the labor market in detail (Yıldırım et al., 2022). This is what makes this study significant. Therefore, we focused on how teachers view the relationship between STEM education and the labor market. Our results provide answers

on further strengthening the link between STEM education and the labor market. Thus, the central question of this study is: "What impact do teachers think STEM education has on the labor market?"

1.2. Literature review

1.2.1. STEM education

Today, people must have various skills due to scientific and technological developments. Therefore, countries are integrating different approaches into their education systems, such as creative problem-solving methods, design-based learning, etc. (Arslan, 2021). One of those approaches is STEM education, which supports 21st-century life skills by associating science, technology, engineering, and mathematics with daily life (Sarıoğlu et al., 2022).

Countries are integrating STEM education into their formal and informal education settings for various reasons (Yıldırım, 2021). First, STEM education helps students develop different skills, such as creative thinking, problem-solving, critical thinking, and computational thinking skills. Second, it makes students more interested in science, technology, engineering, and mathematics and encourages them to pursue careers in those fields (Karakaya et al., 2018). Third, STEM education helps students gain the knowledge and skills necessary for future professions (Karakaya and Avgın, 2016). Fourth, STEM education also enables students to come up with new and different products by producing solutions to daily life problems. Therefore, countries need to include STEM education from an early age. Teachers play a key role in the execution of STEM education (Stohlmann et al., 2012). Therefore, we need to provide them with long-term and comprehensive STEM training programs. Some countries have recognized this and attached importance to teacher training.

1.2.2. STEM education and the labor market

STEM education emphasizes the positive aspects of technological progress while ignoring social problems (inequality and injustice) (Roock and Baildon, 2019). Economic growth is also affected by almost all of these positive aspects. STEM education leads to economic growth because it allows us to prosper. STEM education allows fewer employees to do more work because people with interdisciplinary knowledge and skills in STEM education will be able to do more than one job at the same time (Çepni and Ormancı, 2018). This results in lower wage costs. Lower wages mean higher capital investment. High capital investment means new jobs (Zemtsov, 2020). Therefore, through the labor market channel, STEM education has the greatest impact on the economy. We should provide STEM education to students at the earliest possible age to increase this impact. STEM education from an early age will help children develop many characteristics. For example, Earlier STEM education helps students develop the ability to investigate, analyze, solve problems, and explore (Hafizan et al., 2017). These are the very skills that are in demand in the private sector. People are more efficient and effective in their working lives if they develop problem-solving skills early and look at problems from different perspectives. This means that a smaller number of employees can be much more productive. STEM education provides a different perspective on problem-solving and positively impacts planning and success in business. Moreover, students who have received a STEM education are better than others at planning their businesses and carrying out business processes (Ferreira et al., 2021).

STEM education instills a sense of entrepreneurship in people of all ages. Shahin et al. (2021) found that STEM education increased the entrepreneurial motivation of female students at the secondary school level. STEM education encourages girls to enter entrepreneurship, especially in developing countries. Therefore, countries should take initiative to encourage women to participate in the workforce (The Girl Scout Research Institute, 2012). STEM education could be a driving force in getting women to participate in the workforce because the labor market has an increasing demand for science, technology, engineering, and mathematics (STEM) disciplines.

STEM education is not meeting this demand to its fullest extent (Almeda and Baker, 2020). Therefore, we need to expand physical spaces for STEM education. However, the larger a classroom is, the less efficient and effective the lessons are. This problem is even more pronounced in STEM fields (Kara et al., 2021). Therefore, schools need to hire more teachers to help make STEM more popular. As economic conditions change, more and more students pursue STEM education. People who receive a STEM education are more likely to be involved in the business world, which increases their employability. On the other hand, there will be an increase in the number of teachers in schools as more and more STEM teachers will be in demand.

Migration also has an impact on the economy and the labor market. STEM education differs from country to country. STEM-oriented schools are the basis of STEM education strategies. This leads people to migrate to cities with STEM-oriented schools (Bullock, 2017). As a result, STEM education also increases internal migration. The relationship between STEM education and the labor market strengthens as migration leads to dynamism. These dynamics have two implications. First, employees and jobs will become more harmonious. Second, everyone will be able to find a job that matches his or her qualifications.

In some countries, employees are overqualified. This means there is a mismatch between theoretical skills and the requirements of business life (Chetwynd et al., 2018). As STEM education becomes widespread, it will generate new job positions, reducing the mismatch between employees and qualifications. This will make employees more productive and help the same number of employees to work more efficiently. In other words, unemployment is likely to increase if students do not receive qualified STEM or similar education because STEM education offers four-way education in an interdisciplinary way: science, engineering, mathematics, and technology.

Students who receive this education develop skills that make it easier for them to get jobs. This reduces unemployment (Widayanti and Suyatna, 2019). In addition, the children of parents who receive a STEM education are more advantaged than the children of parents who do not receive a STEM education (Thomas and Lonobile, 2021). Therefore, both the individuals who receive STEM education and their family members benefit from the prevalence of STEM education. If individuals do not receive qualified education, unemployment among low-educated individuals will remain a problem even with economic growth (Aminu, 2019). In some cases, even STEM education may not be able to eliminate disadvantaged groups (social science majors and women). Moreover, social science graduates have more difficulty entering and staying in the labor market than in other fields (Yang, 2018). After receiving a STEM education, women are less likely to engage in entrepreneurial activities than their male counterparts (Kuschel et al., 2020). These disadvantages show us that we should do a better job of planning STEM education programs. Students can benefit more from STEM education if educators

consider these disadvantaged groups in integrating STEM education into curricula. This will further strengthen the link between STEM education and employment. In this way, STEM education can contribute more to the economy.

2. Method

This paper focused on both STEM education and the labor market. Addressing topics in all dimensions requires researchers to adopt ontological and epistemological perspectives (Twining et al., 2017). We focused on teachers' thoughts about how STEM education relates to the workforce. Thus, this study employed both empiricism and interpretation to explain the process. Therefore, we adopted a postpositivist perspective to identify STEM education's impact on the labor market (Creswell and Poth, 2017). Accordingly, the main research question was: "What are teachers' views on the impact of STEM education on the labor market?" To answer this question, this study adopted a qualitative single-case research design. In this context, we adopted a single-case research design, which is a qualitative research method, to validate teachers' opinions about the effects of STEM education on the labor market (Yin, 2014). A case study allows researchers to examine an event in its setting and interpret it holistically (Merriam, 2009). According to Creswell (2007), a case study allows the researcher to examine one or more bounded situations in depth through multi-source data collection tools (observations, interviews, audiovisuals, documents, reports) and to produce qualitative research in which situations and relevant themes are identified. The case of this study is STEM education and workforce. So, In this study, the connection between STEM education and labor force was tried to be explained in line with the views of teachers. Because teachers have a first degree influence on the selection of future professions. When the literature is examined, it is seen that another factor that has an impact on the workforce is STEM education. It is also understood that teachers lack knowledge on how to provide the connection between STEM education and labor force with stem applications. It is important to investigate this situation. For this reason, first of all, teachers were given trainings on stem and workforce, and then the reflections of the workforce and stem trainings given to teachers on teachers' opinions were determined. We trained teachers for 2 months on STEM education and the workforce. We conducted in-depth interviews with them to identify the relationships between STEM education and the workforce. In other words, we trained teachers to elaborate on the process and collected information on the situation at the end of the process.

2.1. Study group

We included teachers who met the predetermined criteria in the study group and sought their opinions. Therefore, we recruited teachers who satisfied the inclusion criteria: (1) having completed the STEM training for 2 months, (2) having participated in all activities related to STEM education and the workforce, and (3) volunteering. The sample consisted of 32 teachers. Participants were teachers from different schools (kindergartens, high schools, etc.). Therefore, they were different branch teachers who taught different subjects. Table 1 shows all participants' sociodemographic characteristics.

2.2. Data collection tools

2.2.1. Semi-structured interview guide

The data were collected using a semi-structured interview guide developed by the researchers. First, they generated a pool of questions about STEM education and the labor market. The draft consisted of six questions. The researchers consulted two experts to check the intelligibility and relevance of the questions. One of the experts had articles on STEM education, while the other expert had published articles on the labor market. The researchers revised the questions based on expert feedback. They conducted a pilot study with two teachers. They revised and finalized the guide based on their feedback (see Appendix-1: Interview Questions).

2.3. Data analysis

Before data collection, the researchers contacted all teachers and informed them about the research purpose and procedure. Then they conducted semi-structured interviews with those who agreed to participate in the study. Each interview lasted 12 to 21 min (544 min in total). The researchers transcribed the interviews. Two experts analyzed the transcripts and developed themes and codes (Yıldırım and Şimşek, 2011). The researchers presented the themes and codes (Tables) in line with the research questions. The researchers ensured intercoder reliability (82%) by getting the two experts to develop the themes and codes (Miles et al., 2014).

The researchers asked all participants to score the questions on a scale of 1 to 5 (according to Table 2) in order to support their views and analyze the interview questions more easily. These questions were asked according to a 5-point Likert type scale, where a maximum

TABLE 1 Sociodemographic characteristics.

Theme	Categories	Codes	f
Sociodemographic characteristics	Gender	Woman	24
		Man	8
	Work experience (year)	1–10	14
		11–18	13
		>21	5
	School type	Public	30
		Private	2
	Education (degree)	Bachelor's	27
		Master's	5
		PhD	1
	Branch	Science	13
		Math	10
		Classroom	5
		Preschool	2
		Physics	2
	School level	Kindergarten	2
		Primary school	5
		Middle school	17
		High school	8

score of 5 and a minimum score of 1 can be given, and scaling can be done to determine at what level the participants' scores will be (Akkuş, 2020). In this way, the researchers checked whether participants' views were consistent. The researchers interpreted participants' scores more easily. In this context, the qualitative data were analyzed using descriptive statistics, making it easier for readers to interpret the findings.

2.4. Validity and reliability

Transferability, credibility, and consistency are critical for validity and reliability (Merriam, 2013). Transferability is achieved by using purposive sampling and explaining the whole research process in detail (Yıldırım and Şimşek, 2011). In the present study, the researchers recruited participants using purposive sampling and explained the whole research process in detail, such as developing the interview guide and collecting and analyzing the data. Experts were involved in the analysis process to achieve credibility. Consistency involves considering findings and conclusions together (Yıldırım and Şimşek, 2011). The researchers provided direct quotes to support their findings in the present study. Moreover, they explained the findings in the Discussion section. All these processes indicate that this study is valid and reliable.

2.5. Context

The researchers interviewed all participants after providing them with a 2-month STEM education. Table 3 shows the STEM education process.

3. Results

Participants' answers were presented in Tables. Each table contained direct quotes to help readers interpret the findings (Table 4).

Participants had different opinions about the impact of STEM education on the workforce. Their views were grouped under two categories: positive and negative. As for positive views, participants stated that STEM education promoted the workforce, provided the necessary knowledge and skills for working life, and created new jobs and professions. As for negative views, they noted that STEM

education might leave some people unemployed, which they called technological unemployment. All in all, most participants had positive views regarding the effect of STEM education on the workforce (Table 5).

Participants' views on the effects of STEM education on underemployment were grouped under two categories and six codes. They stated that STEM education created new job opportunities, encouraged people to work, promoted entrepreneurship, and helped people have second jobs. On the other hand, some participants noted that STEM education pushed people to always look for new jobs and caused job dissatisfaction. Most participants believed that STEM education would reduce underemployment (Table 6).

Participants' views on the effects of STEM education on discouraged employees were grouped under two categories, three subcategories, and nine codes. Most participants stated that STEM education would reduce the number of discouraged employees as they believed that people who received STEM education would be more likely to start their own businesses because it promoted entrepreneurship and employment. However, some participants believed that STEM education would cause technological unemployment (Table 7).

Participants' views of the effects of STEM education on unemployment were grouped under two codes. Most participants believed that STEM education would reduce unemployment rates. However, some participants remarked that STEM education would cause unemployment because more and more people would learn how to use technology (Table 8).

Participants' views of the effects of STEM Education on the number of people excluded from the workforce were grouped under two codes. Most participants stated that STEM education would reduce the number of people excluded from the workforce. On the other hand, some participants believed that STEM education would not impact the number of people excluded from the workforce (Table 9).

Participants' views of the effect of STEM education on social costs were grouped under two categories and six codes. Most participants believed that STEM education would help reduce social costs as it would make attendees happier, reduce suicide rates, alleviate social problems, and prevent brain drain. Some participants noted that STEM education would have an adverse impact on social costs (Table 10).

TABLE 2 Scores.

	Meaning	Explanation
1–1.8	Strongly disagree	STEM education does not affect the labor market.
1.81–2.6	Disagree	STEM education has no positive effect on the labor market
2.61–3.4	Neither disagree nor agree	Undecided about the effect of STEM education on the labor market.
3.41–4.2	Agree	STEM education has a positive effect on the labor market
4.21–5	Strongly agree	STEM education definitely has a positive effect on the labor market

TABLE 3 STEM education process.

Week	Topic	Duration
1.	STEM education and its importance	Two hours
2.	Basic concepts related to STEM education	Two hours
3.	STEM pedagogical content knowledge	Eight hours
4.	STEM education and business life	Two hours
5.	STEM education and professions	Two hours
6.	In-class STEM activities	Two hours
7.	Preparing lesson plans	Six hours
8.	STEM education activities	Six hours
9.	Interviews Nine hours four minutes	

TABLE 4 Participants' views on the effects of STEM education on the workforce.

Theme	Category	Code	Quotes
The effects of STEM education on the workforce	Positive effects	Promoting the workforce ($n = 14$)	"STEM education has a positive impact on the workforce. People with potential are more sought after and are more likely to be hired by employers." P1
		Providing the necessary knowledge and skills for working life ($n = 13$)	"STEM education helps people develop problem-solving and entrepreneurial skills. For example, a factory worker might discover a way to use machines more effectively." P11
		Creating new jobs ($n = 10$)	"Technological developments such as increased automation with artificial intelligence and the Digital Industry create new jobs." P3
		Creating new professions ($n = 8$)	"Students will face different professions in the future. New professions will emerge soon. For this, I believe that our students should receive STEM education to develop their existing but untapped talents." P26
		Increasing productivity ($n = 6$)	"STEM education turns students into productive people…" P13
		Contributing to economic growth ($n = 1$)	"STEM education has a significant impact on economic development." P18
	Negative effects	Causing unemployment ($n = 2$)	"As production increases, labor will not be needed in some areas. But the workforce will increase partly because it creates new job opportunities." P29
		Technological unemployment ($n = 1$)	"STEM education will help reduce human-related forces because it directly affects technology." P24

*More than one answer.

TABLE 5 Participants' views on the effects of STEM education on underemployment.

Theme	Category	Code	Quotes
Underemployment	Decreases	Creating new job opportunities ($n = 17$)	"If you have a skilled workforce or if you have 21st-century skills, you know how to survive the pandemic, and you can easily find a job. So, STEM education also reduces underemployment." P3
		Encouraging people to work ($n = 11$)	"STEM education can prevent underemployment because you can innovate new things and create added value in your sector, field, and discipline. So, it will encourage you to work harder." P14
		Promoting entrepreneurship ($n = 7$)	"STEM education encourages people to work and bring their products to the market. This helps them develop entrepreneurial skills." P19
		Having a second job ($n = 7$)	"STEM education reduces underemployment and enables people to have suitable extra jobs." P20
	Increases	Looking for a new job ($n = 8$)	"People with STEM education are open to interdisciplinary job opportunities because they constantly make connections between different fields. So, they always consider finding new jobs." P12
		Job dissatisfaction ($n = 2$)	"STEM education helps people develop new skills and be satisfied with their work. This motivates them to work harder." P24

*More than one answer.

3.1. Descriptive results

Participants stated that STEM education reduced the number of discouraged workers and those excluded from the workforce. They also noted that STEM education reduced social costs. Moreover, they remarked that STEM education positively impacted underemployment and unemployment. These results indicated that most participants believed that STEM education positively affected the labor market. When we analyze the views of the participants in terms of social cost, it would be appropriate to detail the descriptive results. First of all, STEM education will have a positive effect on social costs. Social costs include an increase in crime rates, dissolution in the social structure, unbalanced migration flows, and suicide. According to our participants, STEM education will positively affect social costs as people will have more job opportunities. Similarly, individuals who develop themselves through STEM education will not be discouraged workers as they will be able to find jobs thanks to their knowledge and skills. Moreover, individuals with improved knowledge and skills will reduce the number of those who cannot enter the labor force.

4. Discussion and conclusion

This section discussed the results regarding the impact of STEM education on the labor market.

According to the first result in line with the main research question, most participants believed that STEM education affected the labor market positively. They noted that STEM education promoted the workforce, created new jobs and professions, and helped students acquire the necessary skills and knowledge for the business world. Research also shows that STEM education creates new jobs and professions and helps students acquire the necessary skills and

TABLE 6 Participants' views on the effects of STEM education on discouraged employees.

Theme	Category	Subcategory	Code	Quote
The effects of STEM education on discouraged employees	Positive	Decreases	Creating one's own job ($n = 15$)	"STEM education allows people to start their own business and helps them develop different skills." P4
			Creating new jobs ($n = 12$)	"STEM education offers new job opportunities because it addresses multiple disciplines." P29
			Promoting entrepreneurship ($n = 9$)	"STEM education turns people into entrepreneurs." P23
			Increasing employment opportunities ($n = 7$)	"STEM education can provide more job opportunities by integrating science, math, technology, and engineering." P5
			Solving problems ($n = 5$)	STEM education reduces the number of discouraged workers. People with STEM education learn to work hard to solve problems." P11
			Motivating ($n = 3$)	"Someone who has received STEM education does not fall into such despair because they have improved themselves." P3
			Skilled workforce ($n = 2$)	"STEM education helps people gain the knowledge and skills needed for the business world. So, they move on to different jobs and keep working."
	Negative	Partly increases	Promoting entrepreneurship ($n = 1$)	"STEM education increases entrepreneurship partly because it promotes it. People with STEM education try to produce their own products and look for markets for them." P25
		Increases	Technological unemployment ($n = 3$)	"STEM education increases the number of discouraged workers because market demand is high. I mean, STEM education causes technological unemployment." P10

*More than one answer.

TABLE 7 Participants' views of the effects of STEM education on unemployment.

Theme	Code	Quotes
Participants' views of the effects of STEM education on unemployment	Decreases ($n = 21$)	"STEM education reduces unemployment rates. It reduces the risk of people being unemployed because it is broad …" P2. "Even if people with STEM education become unemployed, it will not last long. They can somehow find jobs or start their own businesses." P11
	Increases ($n = 11$)	"STEM education may increase the risk of unemployment. Creating new jobs may leave people unemployed." P13 "STEM education will lead to increased technological unemployment because more and more people will learn how to use technology." P28

TABLE 8 Participants' views of the effects of STEM education on the number of people excluded from the workforce.

Theme	Code	Quotes
The effects of STEM education on the number of people Excluded from the Workforce	Decreases ($n = 30$)	"More people will look for skilled labor. Specialists may be wanted as new jobs will emerge. This means these people specializing in STEM education can be included in the workforce." P27
	No effect ($n = 2$)	"I do not think it affects that number because STEM education has nothing to do with being excluded from the workforce." P1

knowledge for the business world (Camilli and Hira, 2019; Andrée and Hansson, 2020). Bacovic et al. (2022) reported a positive correlation between the increase in STEM graduates and economic growth and employment. Talwar and Hancock (2010) emphasized that different professions, such as space pilots, will be popular in the future. However, some participants believed that STEM education might affect the labor market adversely. They remarked that STEM education would cause technological unemployment. Çepni and Ormancı (2018) argue that technological unemployment may occur due to the disappearance of some business areas with technological advances. Yıldırım et al. (2021) also maintain that STEM education

will accelerate technological developments, reducing human-based jobs and increasing unemployment. Our results are consistent with the literature.

According to the second result in line with the main research question, participants stated that STEM education would reduce underemployment as they believed that it would create new jobs, promote entrepreneurship, encourage people to work hard, and get them to find second jobs. However, some participants noted that STEM education would increase underemployment rates as they believed it would cause them to be unhappy with their jobs and seek new job opportunities. Bekki et al. (2018) emphasized that STEM

TABLE 9 Participants' views of the effect of STEM education on social costs.

Theme	Category	Code	Quotes
The effect of STEM education on social costs	Positive	Making one happy ($n = 20$)	"Regarding social costs, people who receive STEM education are more self-confident and morally stronger because they are better equipped. From this point of view, it can also have a reducing effect on social costs." P26
		Preventing brain drain ($n = 8$)	"STEM education may prevent brain drain and minimize unemployment." P7
		Alleviating social problems ($n = 4$)	"STEM education will have positive social impacts. The economic cost will be positively affected, and the social cost will be positively affected. This will reduce social problems." P17
		Reducing suicide rates ($n = 3$)	"People who receive STEM education will have high hopes of finding jobs, which will reduce unemployment rates. Plus, it will reduce suicide rates related to unemployment."
	Negative	Job dissatisfaction ($n = 2$)	"STEM education helps people acquire new knowledge and skills. So, they want to have good jobs. When they cannot find a job, social costs increase because they will be unhappy." P19
		No effect ($n = 1$)	"STEM education may not have an impact on social costs. Therefore, I do not think it will have a positive impact." P7

*More than one answer.

TABLE 10 Descriptive results.

Question No	Question	M	SD
1	The impact of STEM education on the workforce	4.47	1.11
2	The impact of STEM education on underemployment	3.81	1.51
3	The impact of STEM education on discouraged workers	4.44	1.34
4	The impact of STEM education on unemployment	3.66	1.62
5	The impact of STEM education on the number of people excluded from the workforce	4.41	0.84
6	The impact of STEM education on social costs	4.22	1.07

education helped students develop entrepreneurial skills and changed their views about finding jobs. Yaki et al. (2021) also maintain that STEM education encourages students to develop entrepreneurial skills. Our results are consistent with the literature.

According to the third result in line with the main research question, most participants noted that STEM education reduced the number of discouraged workers. They stated that STEM education created new jobs, promoted entrepreneurship, increased employment, and encouraged people to solve problems and start their own businesses. Yang (2018) remarked that people who received STEM education did not need job mobility as that education equipped them with the necessary skills. Moreover, Bekki et al. (2018) highlighted that STEM education provided people with entrepreneurial skills necessary for the business world. On the other hand, some of our participants believed that STEM education partially affected discouraged workers or increased the number of discouraged workers. Our results are consistent with the literature (Yaki et al., 2021; Barau et al., 2022).

According to the fourth result in line with the main research question, most participants remarked that STEM education reduced the number of unemployed people. Research shows that STEM education provides new lines of business (Kertil and Gurel, 2016; Widayanti and Suyatna, 2019; Yıldırım et al., 2021). Fahmy and Naqvi

(2022) state that there will be more STEM-related lines of business in the future. However, some participants believed that STEM education would cause technological unemployment. Çepni and Ormancı (2018) also argue that technological advances thanks to STEM education will cause technological unemployment. Although some researchers report a positive correlation between STEM education and technological unemployment, many others maintain that STEM education will result in more job opportunities, reducing unemployment rates (Talwar and Hancock, 2010; White and Shakibnia, 2019; Mystakidis and Christopoulos, 2022). Our results are consistent with the literature.

According to the fifth result in line with the main research question, most participants stated that STEM education would reduce the number of those not included in the labor force. However, some participants did not believe that STEM education would affect people excluded from the workforce. Fahmy and Naqvi (2022) maintain that STEM education will reduce the number of people not in the labor force. Langdon et al. (2011) also argue that STEM education graduates are less likely to experience unemployment. Our results are consistent with the literature.

According to the sixth result in line with the main research question, participants stated that STEM education affected social costs positively. Participants noted that STEM education made people happy, prevented brain drain, and reduced social problems and suicide rates. This is because STEM education helps people improve themselves and makes them more equipped to find jobs that fit their skills. However, some participants believed that STEM education would make people dissatisfied with their jobs because they would be overqualified. Some participants noted that STEM education would not affect social costs. Our results are consistent with the literature.

The seventh result in line with the main research question showed that STEM education would positively impact the workforce and discouraged workers and those excluded from the workforce. The results suggested that STEM education would reduce social costs and the number of those excluded from the workforce. Moreover, the results showed that STEM education would reduce underemployment and unemployment rates. Participants' views and their descriptive analysis results are consistent.

5. Limitations and recommendations for further research

This study had three limitations. First, the results are sample-specific and cannot be generalized to the whole population. Second, the results are based on self-report. Researchers should adopt mixed-method research designs to better understand what teachers think about the impact of STEM education on the labor market. Third, we focused only on the impact of STEM education on the labor market. Researchers should conduct further research to better understand the impact of STEM education on different types of unemployment (e.g., technological unemployment) and new professions.

6. Implications for future research on STEM education

Some implications for future research were made in light of the results.

1. We need to focus on STEM training because teachers are responsible for delivering STEM education. In this way, we can make STEM education more popular and widespread.
2. We should use materials, 3D printers, and robotic coding materials that will attract students' interest in STEM fields and enable them to produce solutions to real-world problems.
3. We should encourage students to attend seminars about career opportunities and future professions in STEM fields. We should also organize seminars that address the link between STEM professions and STEM education. Such seminars can help students to plan their careers in STEM fields.

4. Schools should allocate more budget for STEM education and provide environments where teachers can work collaboratively.

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

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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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7. Appendix-1: Interview questions

1. How do you think STEM education affects the workforce?
2. How do you think STEM education affects underemployment?
3. How do you think STEM education affects discouraged workers?
4. How do you think STEM education affects unemployment?
5. How do you think STEM education affects the number of unemployed people?
6. How do you think STEM education affects social costs?

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A meta-analysis of effects of blended learning on performance, attitude, achievement, and engagement across different countries

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While this special pandemic period has been seeing an increasing use of blended learning, few studies have meta-analytically reviewed the effectiveness of blended learning in different countries. This meta-analysis summarizes previous studies on blended learning effectiveness in different countries in terms of students' performance, students' attitudes toward blended learning, learning achievement, and student engagement in different countries. Through the meta-analysis via Stata/MP 14.0, it is concluded that blended learning can improve performance, attitude, and achievement in most countries. However, in both China and the USA, blended learning cannot significantly improve student engagement in academic activities. No significant differences were revealed in student performance in the USA between blended and non-blended learning. Future research can extend the research into blended learning to more countries and areas across the world.

1. Introduction

This special pandemic time has been witnessing the popularity of blended learning approaches. However, very few studies have summarized blended learning effectiveness in different countries. It is thus meaningful and necessary to examine the effectiveness of blended learning across the world especially during this special time.

1.1. Definitions of blended learning

Blended learning, a combination of virtual and physical learning conditions (Al-Qatawneh et al., 2020; Yu et al., 2022), is defined as a learning strategy integrating two different educational models, e.g. distance and traditional learning (Bonk and Graham, 2006). There are three most popular definitions of blended learning (Bonk and Graham, 2012), blending instructional modalities (Yu, 2015; Thomson, 2020; Min and Yu, 2023a), instructional methods (Li and Yu, 2023), and online learning with face-to-face instructional approaches (Young, 2002; Ward and LaBranche, 2003).

1.2. Performance

Performance in blended learning can be defined as the measurable outcomes of a student's achievement in both online and offline learning environments (Spanjers et al., 2015). Assessment, evaluation, and analysis can be used to describe performance in blended learning. Some potential ways to assess performance in blended learning include evaluating the quality of student work, analyzing student participation in online discussions, and measuring improvement in learning outcomes from before and after blended learning experiences. The assessment of performance in blended learning should also consider factors such as critical thinking, knowledge delivery, disposition improvement, knowledge and skill improvement, as these have been shown to affect overall success in the blended learning environment.

Most studies positively reported blended learning performances. Performances in this study include the variables: critical thinking skills, knowledge delivery, disposition improvement, knowledge and skill improvement, language use, listening skills, speaking skills, and topic development. Blended learning, outperforming full online learning in the aspects of motivation, attitudes, and satisfaction, can improve nurses' clinical knowledge compared with the traditional learning approach in the UK (McCutcheon et al., 2018). Blended learning can optimize the learning flexibility in terms of time and space, leading to stable learning performance of undergraduates in The Zurich University in Germany (Mueller et al., 2020). It was revealed that both classroom and online learning could enhance American students' learning performance, but the blended learning brought about the largest gain in performance in the USA (Hill et al., 2017). Blended learning could give rise to significantly higher learning performance than e-learning, while the flipped classroom could improve intrinsic motivation and self-efficacy in Can Tho University in Vietnam (Thai et al., 2017).

Numerous studies reported that blended learning was beneficial to language proficiency improvements. Blended learning could greatly improve the reading abilities of children in a kindergarten in the USA (Macaruso et al., 2020). Blended instruction could greatly improve students' English writing abilities in Ankang College, Shanxi China (Zhou, 2018). Blended learning could improve students' English listening and speaking and critical thinking skills, e.g. analysis, inference, evaluation, induction, and deduction in China (Yang et al., 2013). Blended learning could enable Chinese college students to extensively practice with flexible time and space, greatly improving their English reading skills (Yang, 2012).

Blended learning could also enhance high-order abilities such as communication, problem-solving, and reasoning skills. Blending a class video blog into face-to-face instruction could improve language oral proficiency but failed to greatly improve the voluntariness to communication using the target language in China (Liu, 2016). Blended learning could effectively facilitate communication skills and improve learning outcomes of nursing tertiary students in Singapore (Shorey et al., 2018). In the blended learning, Chinese students could discuss with peers, propose meaningful ideas, mutually learn and share, improve group work skills, enhance self-perception, and facilitate reasoning skills (Monteiro and Morrison, 2014). Blended learning could

enhance acute stroke patients' competences, e.g., recognition and management in the USA (Lee Gordon et al., 2005).

1.3. Attitude

Attitude toward blended learning can be defined as an individual's disposition or perspective regarding the use of a combination of online and traditional face-to-face teaching methods to deliver educational content (Inal and Korkmaz, 2019). This approach provides a flexible and interactive learning environment that allows students to develop their skills and enhance their knowledge through various multimedia channels. One can describe the attitude toward blended learning by examining students' engagement levels, preferences, and motivation toward the use of technology-enhanced learning. Additionally, the effectiveness and efficiency of blended learning can be measured by analyzing students' performance and outcomes in both the physical and virtual learning spaces. The construct attitude in this study includes: self-assessment-cognition, attitudes toward blended learning, blended learning satisfaction, communication skills, self-efficacy, motivation, and confidence.

The majority of learners positively assess the blended learning effectiveness. Blended learning, conducive to students' positive attitude and satisfaction, could improve English listening skills and enhance vocabulary acquisition among junior middle school students in China (Jia et al., 2012). Chinese 11th graders held significantly more positive attitudes toward blended learning than traditional learning (Chang et al., 2014). Singaporean nursing college students had greatly positive attitude toward blended learning, as well as communication skills in the blended context (Shorey et al., 2018). The blended model in active learning classrooms obtained positive evaluation and students held improved attitudes toward physics courses in North Carolina State University in the USA (Beichner et al., 2007). Blended learning could improve nursing students' motivation, satisfaction, and attitude in clinical supervision skills compared with online-only learning in China (Chang et al., 2014).

1.4. Achievement

Achievement in blended learning can be defined as the level of success or accomplishment that students attain when participating and completing a blend of online and traditional face-to-face learning activities (Inal and Korkmaz, 2019). This measure of achievement encompasses various learning outcomes, such as improved academic performance, increased engagement, and enhanced critical thinking and problem-solving abilities. In blended learning, the achievement can be assessed through a variety of methods, including graded quizzes and assignments, class participation, peer evaluations, and self-reflection. Additionally, the use of learning analytics and data-driven assessment measures can provide valuable insights into students' progress and provide feedback to instructors for more personalized and effective teaching strategies. Overall, achievement in blended learning is determined

by the effectiveness of the instructional design, the quality of the learning materials, and the level of support provided to students throughout the learning process. Achievements in this study include: exam scores, students' knowledge state, writing content relevance, English test scores, actual grades in the academic goal planning assignment, achievement test scores, course grades, level of knowledge, gain in knowledge, student learning outcomes, reading achievements, and academic progress.

Many studies reported that blended learning could contribute to higher learning achievements than traditional approaches. Blended learning could give rise to significantly higher academic achievements than traditional face-to-face learning in Canada (Bazelais and Doleck, 2018). Online learning activities could improve students' academic achievements among undergraduate students in University of Granada in Spain, where influencing factors included attendance rate and students' backgrounds rather than the time they spent on learning (López-Pérez et al., 2013; Min and Yu, 2023b). Blended learning via information and communication technologies could significantly improve learning achievements of mechanical couplings in engineering in Spain (Cortizo et al., 2010). A blended and flipped pedagogical approach could improve learning achievements and learning environment and raise the efficiency of space use in the USA (Baepler et al., 2014).

1.5. Engagement

Engagement in blended learning can be defined as the degree to which students are actively involved and invested in the learning process, both online and in-person (George-Walker et al., 2010). This engagement encompasses a wide range of behaviors, including active participation in discussions and group activities, completing assignments and coursework, and seeking out additional learning opportunities outside the formal curriculum. In blended learning, engagement can be fostered through various strategies, such as providing opportunities for students to collaborate and work together, providing feedback on student work, and using interactive multimedia tools and resources to enhance the learning experience. Engagement can also be measured through assessments, such as self-reflection surveys, course evaluations, and quizzes that measure participation and effort. Overall, engagement in blended learning is crucial for promoting student motivation, improving learning outcomes, and creating a supportive learning environment that promotes academic success. The construct engagement in this study includes: time spent learning, student perception of the learning space, and the perception of problem solution.

Most previous studies reported that blended learning could improve learning engagement. Blended learning, encouraging students to engage in learning even after class, could give rise to a significantly higher frequency and level of engagement than the traditional learning in Spain (Pérez-Marín and Pascual-Nieto, 2011). In the technology-oriented blended learning, Chinese freshmen used to spend more time on in-class discussion and writing tasks than the efficiency-oriented group. The interaction was considered an important factor influencing blended learning effectiveness among Chinese freshmen (Yen and Lee, 2011). Undergraduates at Point Loma Nazarene University in the USA

spent significantly more time learning in a blended instruction model than in the traditional instruction model (Botts et al., 2018). Blended learning could improve Chinese students' engagement by increasing their learning efficiency and effectiveness (Monteiro and Morrison, 2014).

1.6. Contradictory findings

Although blended learning is a popular teaching method, there have been conflicting findings regarding its impact on academic achievement in different countries. For instance, a study conducted in China found that while students believed that blended learning had a positive impact on their achievement, empirical evidence showed no significant improvement (Chang et al., 2014). Similarly, research conducted in Hong Kong China indicated no significant differences in Fashion learning achievements between blended and traditional approaches (Yick et al., 2019). Additionally, research conducted in an American university showed no demonstrable benefits of blended learning in terms of learning outcomes for economics courses (Olitsky and Cosgrove, 2014). Even when blended learning does show some positive benefits, such as an improvement in self-assessment of knowledge gains, this does not necessarily translate into improved academic achievement for Chinese learners (Chang et al., 2014).

Research on blended learning has yielded inconsistent findings regarding its impact on attitude, performance, and engagement. For instance, a study conducted in the United Arab Emirates found no significant differences in attitudes toward blended or traditional approaches, which could be due to either internal or external factors (Al-Qatawneh et al., 2020). Meanwhile, a study in China revealed that efficiency-oriented blended learning significantly improved problem-solving performance among freshmen when compared with hybrid-oriented and technology-oriented groups (Yen and Lee, 2011).

However, research conducted at Point Loma Nazarene University in the USA showed no significant differences between blended and traditional instruction for an upper-division quantitative literacy course, and students also spent less time learning in blended courses (Botts et al., 2018). In a separate study, students in a blended learning course at an undergraduate university in Alberta, Canada had no significant differences in self-efficacy and knowledge scores compared to those using non-blended instruction, despite positively perceiving blended learning (Berga et al., 2021). Overall, the impact of blended learning on attitude, performance, and engagement is inconclusive and may vary depending on factors such as the type of blended learning used and the context in which it is employed.

1.7. Research gap

The research gap in previous literature is a lack of comprehensive and up-to-date understanding of the impact of blended learning on performance, attitude, achievement, and engagement in countries with diverse socio-cultural contexts, educational systems and levels, and technological infrastructure.

The study aims to address this gap by exploring the magnitude and variability of the effects of blended learning on multiple performance, attitude, achievement, and engagement indicators across different countries, as well as identifying factors that moderate or enhance these effects. The meta-analysis also helps identify gaps in the research literature and suggest future research directions that will inform evidence-based practice and policy in the field of education.

1.8. Research questions

Considering the inconsistent findings regarding the influence of blended learning on learner performance, attitude, achievements, and engagement in different countries, we propose four research questions, i.e. (1) Can blended learning positively influence student performance in different countries such as Canada, China, Germany, Spain, The United Arab Emirates, UK, USA, Vietnam, and Singapore? (2) Can blended learning positively influence student attitude in different countries such as Canada, China, Germany, Spain, The United Arab Emirates, UK, USA, Vietnam, and Singapore? (3) Can blended learning positively influence learning achievement in different countries such as Canada, China, Germany, Spain, The United Arab Emirates, UK, USA, Vietnam, and Singapore? (4) Can blended learning positively influence student engagement in different countries such as Canada, China, Germany, Spain, The United Arab Emirates, UK, USA, Vietnam, and Singapore?

2. Methods

This meta-analysis was implemented according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). PRISMA is an evidence-based reporting guideline that provides a checklist of items to include when conducting a systematic review or meta-analysis. PRISMA aims to improve the reporting quality and transparency of systematic reviews and meta-analyses by providing a standardized framework that facilitates the critical appraisal and synthesis of research evidence.

PRISMA consists of a 27-item checklist that covers the title, abstract, introduction, methods, results, discussion, and funding sections of a systematic review or meta-analysis. The checklist includes items such as information on the research question, inclusion and exclusion criteria, search strategy, data extraction, risk of bias assessment, synthesis of results, and limitations of the study. In addition to the checklist, PRISMA also includes a flowchart that illustrates the process of selecting studies for inclusion in the systematic review or meta-analysis. The flowchart outlines the number of studies that were initially identified, the number that were excluded based on inclusion and exclusion criteria, and the number that were finally included in the review. PRISMA has become a widely adopted reporting guideline in the field of healthcare research and has been found to improve the quality and transparency of systematic reviews and meta-analyses. Its implementation has also allowed for greater comparability and

synthesis of research evidence, which ultimately supports evidence-based decision making in healthcare.

2.2. Eligibility criteria

The studies will be considered eligible and included if they (1) focus on the effect of blended learning on performance, student attitude, achievements, and engagement in different countries; (2) are highly evaluated using University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003); (3) can provide enough data for a meta-analysis; (4) divide the participants into both control and experimental groups for a comparative analysis between blended learning and non-blended learning; and (5) are written in the standard English language.

The studies will be considered ineligible and excluded if they (1) focus on blended learning technologies themselves rather than blended learning effect; (2) cannot provide enough data for a meta-analysis even after we correspond with the authors; (3) are not written in English; or (4) they are poorly evaluated using University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003).

2.3. Data sources and search strategy

Based on the PRISMA flow (Figure 1), we conducted the inclusion and exclusion process. To maximize the number of data included, we searched the databases from their inception until February 26, 2023 without time limitation. We entered keywords and index terms, e.g., *blended learning, performance, attitude, achievements,* and *engagement, different countries*, into different databases according to their specific syntactical rules. We obtained 12,098 results by searching four online databases, i.e., Elsevier ScienceDirect, Taylor and Francis Group, EBSCOhost, and Springer. Then we entered the results into ENDNOTE X8 (Thomson Reuters, New York, USA) to remove those duplicated. Then we invited two researchers to double-check whether or not the results are related to the study by screening the titles and abstracts. After this, they conducted the evaluation of eligibility of the results.

Finally, two researchers met to decide on the included studies for the meta-analysis. They discussed different selected studies and negotiated to address the disputes. Those selected by both of them were directly included in the meta-analysis. A third reviewer will be invited to finally determine the finally selected studies in case two researchers cannot reach an agreement on the inclusion of any study.

2.4. Evaluation of included studies

We evaluated the full texts via University of West England Framework for Critically Appraising Research Articles (Moule et al., 2003). This framework evaluates the research articles based on five sections, i.e., the introduction, the methods, ethics, the results/findings, and the conclusions. Each section

FIGURE 1
A flowchart of literature inclusion.
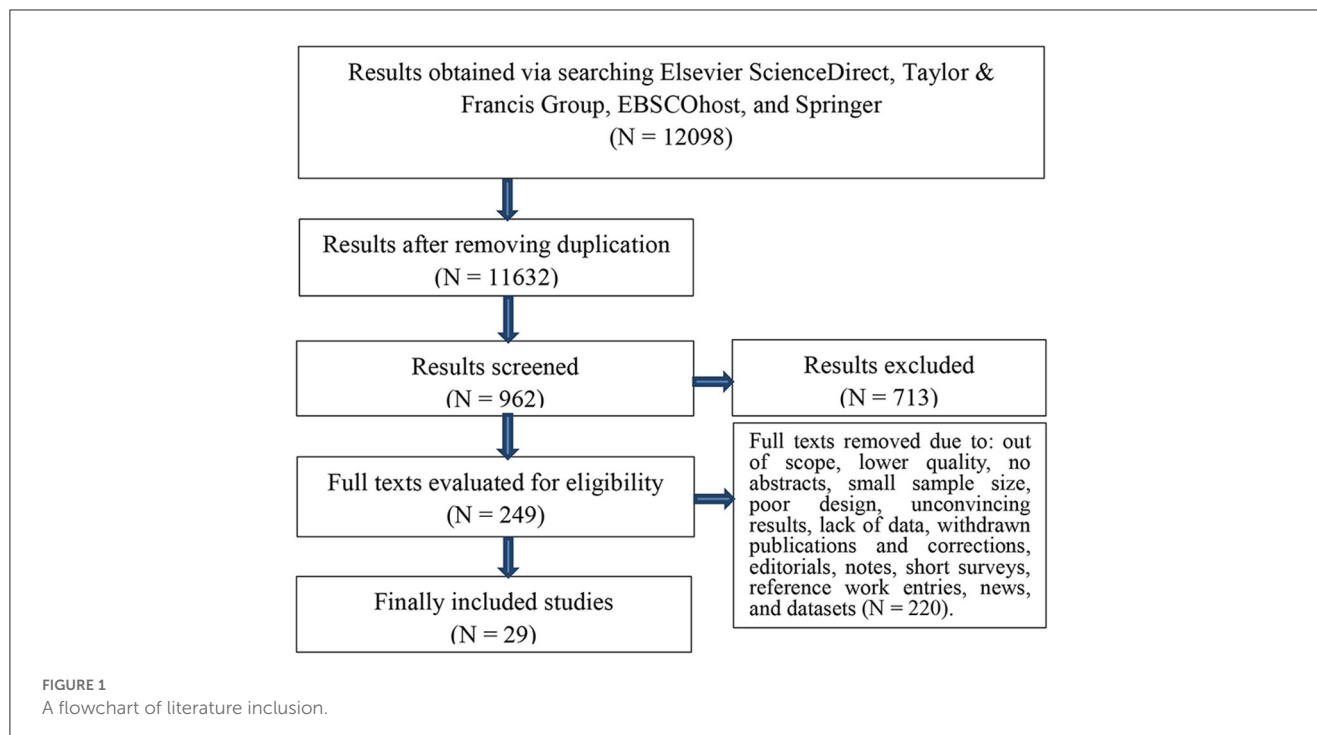
has detailed criteria for evaluation. For the method section, we use different criteria for different methods, e.g., qualitative or quantitative research. We also use specific criteria to evaluate data collection and analysis. We finally included 29 results for the meta-analysis (Table 1). The inter-rater consistency reaches a satisfactory level (Cohen's kappa coefficient $t = 0.83$). This indicates that two researchers mostly selected the same studies or generally reached an agreement on most of the selected studies.

2.5. Data extraction

Two professor solicited specific information such as author, publication year, and the source of the literature. We also collected enough data for the meta-analysis such as means, standard deviations, and numbers of participants for both control and experimental groups. For convenience of analysis, we classified the findings into *performance, attitude, achievements,* and *engagement,* followed by the countries where the studies were conducted. The selected were implemented in various countries across the world such as China, the United Arab Emirates, Canada, the USA, Spain, Germany, Singapore, and Vietnam. We will compare different effects of blended learning in these countries. Similarly, both researchers would meet up to discuss different results of data extraction and a third reviewer would be invited to decide the final data if any disagreement occurred between two researchers. The inter-rater consistency also reaches a satisfactory level (Cohen's kappa coefficient $t = 0.81$).

2.6. Statistical analysis

We meta-analytically examined the data using Stata/MP 14.0. After entering data such as numbers of participants, means, and standard deviations for both groups into Stata/MP 14.0, forest plots will be drawn. We calculated *standardized mean difference* (SMD or Cohen d) (Cohen, 1988) indicating the effect sizes, *weight* indicating the degree of the influence on pooled results, and 95% confidence interval indicating the study reliability. Cohen d is produced through dividing the mean difference between both groups by the pooled standard deviation of both groups (Sedgwick and Marston, 2013). The formula is: Cohen $d = $ (M2-M1)/Pooled SD, where M1 indicates the mean of the control group) and M2 indicates the mean of the experimental group. The effect size will be deemed *very small* if d approximates 0.1, *small* if d approximates 0.2, *medium* if d approximates 0.5, *large* if d approximates 0.8, *very large* if d approximates 1.2, *huge* if d approximates 2.0 (Sawilowsky, 2009).

To determine whether a random-effect or a fixed-effect model could be adopted, we also tested the heterogeneity of the effect sizes using I^2 and p values. The formula to calculate I^2 is: $I^2 = [(Q\text{-df})/Q] \times 100\%$, where Q indicates the Chi-squared statistics and df means the degree of freedom (Higgins and Thompson, 2002; Higgins et al., 2003). This indicates the degree of percentage of the variability in effect sizes caused by heterogeneity or random errors. According to Higgins and Green (2021), the heterogeneity will be considered *unimportant* in case I^2 ranges from 0 to 40%, *moderate* in case I^2 ranges from 30 to 60%, *substantial* in case I^2 ranges from 50 to 90%, and *considerable* in case I^2 ranges from 75 to 100%. Generally, if I^2 is larger than 50% ($p < 0.05$), we will adopt a random-effect model to conduct the meta-analysis, and if I^2 is smaller than 50% (p

TABLE 1 The included studies for the meta-analysis.

N	Author/year	Source	Subgroup	Country
1	Al-Qatawneh et al. (2020)	Springer	Achievement and attitude	The United Arab Emirates
2	Baepler et al. (2014)	Elsevier	Achievement, attitude, engagement, and performance	USA
3	Bazelais and Doleck (2018)	Springer	Achievement	Canada
4	Botts et al. (2018)	Taylor and Francis	Engagement	USA
5	Chang et al. (2014)	EBSCOhost	Achievement, attitude, and performance	China
6	Cortizo et al. (2010)	Elsevier	Achievement	Spain
7	Lee Gordon et al. (2005)	EBSCOhost	Achievement	USA
8	Hill et al. (2017)	EBSCOhost	Achievement	USA
9	Jia et al. (2012)	Elsevier	Achievement	China
10	Liu (2016)	Elsevier	Achievement and performance	China
11	López-Pérez et al. (2013)	Springer	Achievement	Spain
12	Macaruso et al. (2020)	Springer	Achievement	USA
13	McCarthy et al. (2020)	Taylor and Francis	Achievement	USA
14	McCutcheon et al. (2018)	Elsevier	Achievement and attitude	UK
15	Monteiro and Morrison (2014)	Taylor and Francis	Engagement	China
16	Mueller et al. (2020)	Taylor and Francis	Achievement	Germany
17	Olitsky and Cosgrove (2014)	Elsevier	Achievement and performance	USA
18	Pérez-Marín and Pascual-Nieto (2011)	Springer	Achievement	Spain
19	Shorey et al. (2018)	Elsevier	Attitude	Singapore
20	Thai et al. (2017)	Elsevier	Achievement, attitude, and performance	Vietnam
21	Yang et al. (2013)	Elsevier	Performance	China
22	Yang (2012)	Taylor and Francis	Performance	China
23	Yen and Lee (2011)	Elsevier	Performance	China
24	Yen and Lee (2011)	Elsevier	Achievement	China
25	Yick et al. (2019)	Taylor and Francis	Achievement	China
26	Zhou (2018)	EBSCOhost	Achievement	China
27	Huang et al. (2022)	Elsevier	Performance	China
28	Rattanasak (2023)	MERT BASTAS PUBLISHING CO	Performance	Thailand
29	Zhou (2023)	Routledge	Achievement	China

> 0.05), we will use a fixed-effect model to run the meta-analysis. The influence analysis program will be used to run the sensitivity analysis. Both Begg and Mazumdar (1994) and Egger et al. (1997) tests will be used to test the publication bias.

3. Results

3.1. Tests of publication bias

Publication bias in a meta-analysis refers to the systematic exclusion or underrepresentation of studies with negative or non-significant results from the analysis. This occurs when studies that report significant or positive findings are more likely to be published in academic journals, while studies with null or negative findings are less likely to be published. As a result, when a meta-analysis is conducted, there is a risk that it may overestimate the effects of an intervention or treatment due to the missing or underrepresented data. This bias can lead to incorrect conclusions and incorrect recommendations for clinical practice. Publication bias can also occur for a variety of reasons, including the behavior of authors, reviewers, and editors, as well as the funding source of the studies. To address publication bias in a meta-analysis, researchers can use methods such as funnel plots, which help identify any asymmetry in the distribution of studies. They can also conduct sensitivity analyses to examine the impact of potential studies that may be missing. Additionally, researchers can conduct a comprehensive search for

all studies, including unpublished studies, to reduce the risk of publication bias.

To test the publication bias, we firstly entered data, e.g., means, standard deviation, and numbers of participants across both groups, into Stata/MP 14.0 to run the meta-analysis. Then, we obtained effect sizes (ES) and standard errors of effect sizes (seES) for the test of publication bias. We tested the publication bias by entering "ES, seES" into Stata/MP 14.0, leading to a funnel plot (Figure 2) and related data. A dot indicates an individual study, and the middle line is the no-effect line. If the dots are symmetrically distributed along both sides of the no-effect line, there will be an absence of publication bias. On the contrary, the asymmetrical distribution indicates the presence of publication bias. As shown in Figure 2, it is hard to conclude that the dots are symmetrically distributed, indicating the presence of publication bias. Both Begg's (Q = 1016, S.D. = 381.89, z = 2.66, p = 0.008) and Egger's tests (Coefficient$t$ = 1.55, S.E. = 0.48, t = 3.25, p = 0.002, 95% CI = 0.60∼2.48) also indicate the presence of publication bias.

3.2. A sensitivity analysis

We conducted a sensitivity analysis to test the reliability and stability of the obtained effect sizes using the program "metan-based influence analysis". To retrieve the result, we entered the data such as means, standard deviations, and numbers of both groups into Stata/MP 14.0. We adopted a random-effect model to conduct the sensitivity analysis due to the high degree of percentage of variability caused by heterogeneity (Q = 1053.01, I^2 = 89.7%, z = 8.88, p < 0.01).

Unstable ES estimates often lead to skewed distribution and are frequently located beyond the lower and upper bounds of 95% confidence intervals (Borenstein et al., 2009). It is thus a must to identify whether there is any estimate located beyond the scope of 95% confidence intervals (Borenstein et al., 2009). As shown in Figure 3, a dot indicates an estimated effect size of an individual study. All the effect sizes are located within the low and upper bounds of 95% confidence intervals. This indicates that there are no unstable ES estimates. We, therefore, conclude that the meta-analysis results are stable.

3.3. Can blended learning positively influence student performance in different countries?

To determine student performance in blended and non-blended learning modes in different countries, we retrieved 27 effect sizes from different countries, where 18 effect sizes sourced from China, 8 from the USA, and 1 from Vietnam. We failed to obtain an effect size from a study (Yang et al., 2013) because one of the standard deviation values is zero. We obtained meta-analytical data and a forest plot (Figure 4) after entering means, standard deviations and, numbers across both groups into Stata/MP 14.0 to run the meta-analysis by the variable *country*.

Figure 4 is a forest plot, a type of graph commonly used in meta-analyses to display the results of multiple studies on a particular topic. In the case of student performance in different countries, a forest plot will provide a visualization of the main findings of a meta-analysis that looked at academic performance of students in different countries. In Figure 4, each study is represented by a horizontal line called a square. The size of the square represents the weight or sample size of the study that contributes to the overall analysis. The position of the square on the vertical axis represents the effect size of the study. In the context of student performance, the effect size may be represented as standardized test scores or other measures of academic achievement.

The forest plot also includes a vertical line (often called a diamond) that represents the overall effect size of the meta-analysis. The width of the diamond reflects the confidence interval of the effect size. In the case of the student performance meta-analysis, each square in the forest plot will represent a study that measured academic achievement in different countries. The position of each square on the vertical axis will represent the effect size or standardized test scores in that country. By analyzing the forest plot, researchers can identify which countries have higher or lower academic performance on average, and compare the effect sizes of different studies to assess the consistency of the results across the studies in the meta-analysis. Forest plots can help researchers and policymakers understand how countries compare to each other in terms of academic performance and make more informed decisions about educational policy.

As shown in Figure 4, the diamonds at the bottom indicate the pooled results. In the left-most column are displayed the author names and publication years, followed by a middle line with numerous boxes. The middle line is referred to as a no-effect line because if a diamond crosses it, the result will be considered insignificant. A box, integrated with a horizontal line and a dot, indicates an individual study. The length of the horizontal line is negatively related to the reliability of the study. The dot indicates the SMD. On the right are displayed the statistics of SMDs (Cohen d) and 95% confidence intervals after them. The right-most column shows the weights indicating the influence of effect sizes on the pooled result.

We adopted a random-effect model to run the meta-analysis of the data sourcing from China (I^2 = 91.2%, p < 0.01), the USA (I^2 = 90.4%, p < 0.01) and Vietnam (a single study) due to a generally high degree of percentage of variability caused by heterogeneity (I^2 = 92.9%, p < 0.01).

As for the meta-analysis of data sourcing from China and Vietnam, the diamonds are located to the right of the no-effect line. This indicates that student performances in the blended learning context in China (d = 0.77, 95% CI = 0.44∼1.10, z = 4.59, p < 0.01) and Vietnam (d = 0.66, 95% CI = 0.06∼1.27, z = 2.14, p = 0.032) are significantly higher than the non-blended. However, the diamond retrieved from the data sourcing from the USA crossed the no-effect line, indicating that student performance in the blended learning context in the USA (d = −0.02, 95% CI = −0.27∼0.23, z = 0.19, p = 0.853) is not significantly higher than the non-blended. The overall results indicate that the blended learning can lead to significantly (d = 0.50, 95% CI = 0.27∼0.74, z = 4.24, p < 0.01) higher student performance than the non-blended since the diamond is located to the right of the no-effect
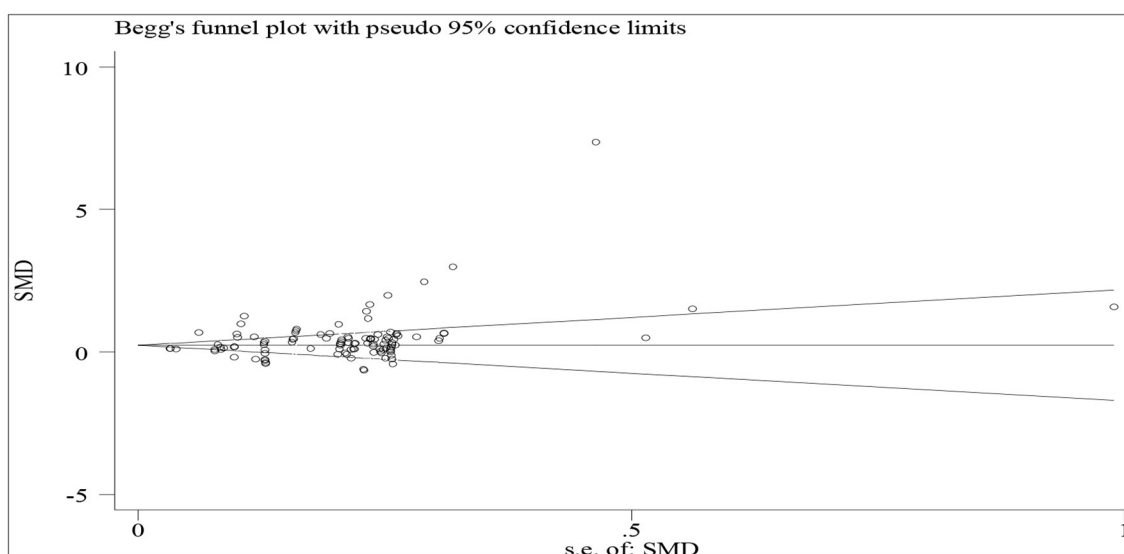
FIGURE 2
A funnel plot of tests for publication bias.
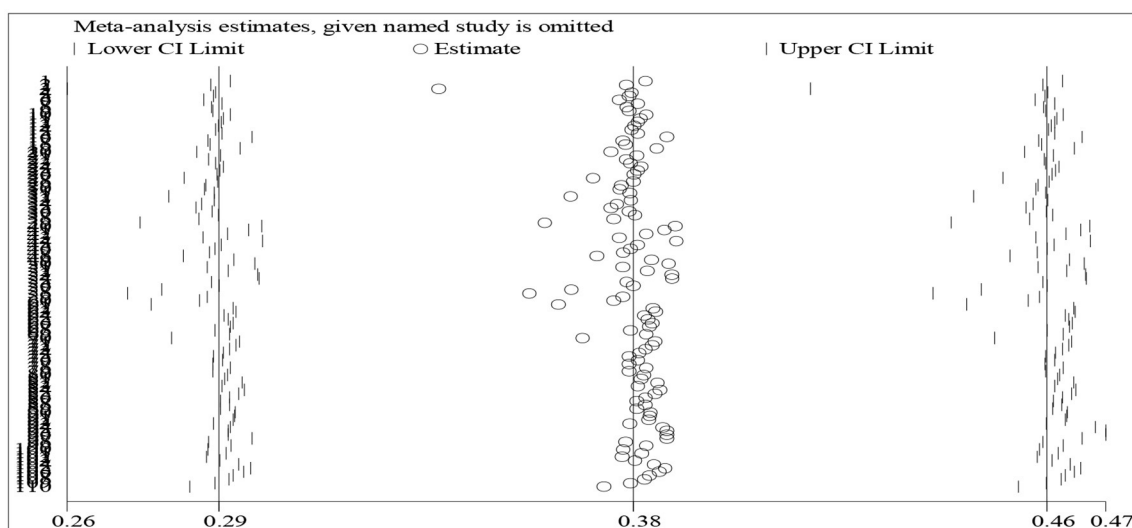
FIGURE 3
A plot of results of the sensitivity analysis.

line. In general, we believe that blended learning could positively influence student performance in different countries.

3.4. Can blended learning positively influence student attitude in different countries?

To determine the differences in student attitudes between blended and non-blended learning in different countries, we obtained totally 11 effect sizes from the studies sourcing from the United Arab Emirates, China, Singapore, Vietnam, the UK, and the USA. We adopted a random-effect model to conduct the meta-analysis due to the high degree of percentage of variability of the effects sizes sourcing from different countries caused by heterogeneity ($I^2 = 76.9\%$, $p < 0.01$).

Figure 5, a forest plot of student attitude toward blended learning in different countries, will likewise show a graphical representation of the results of a meta-analysis of studies on this topic. Each study in the meta-analysis will be represented by a square on the graph, with the size of the square representing the sample size of the study, and the position on the vertical axis representing the effect size of the study (i.e., the average student
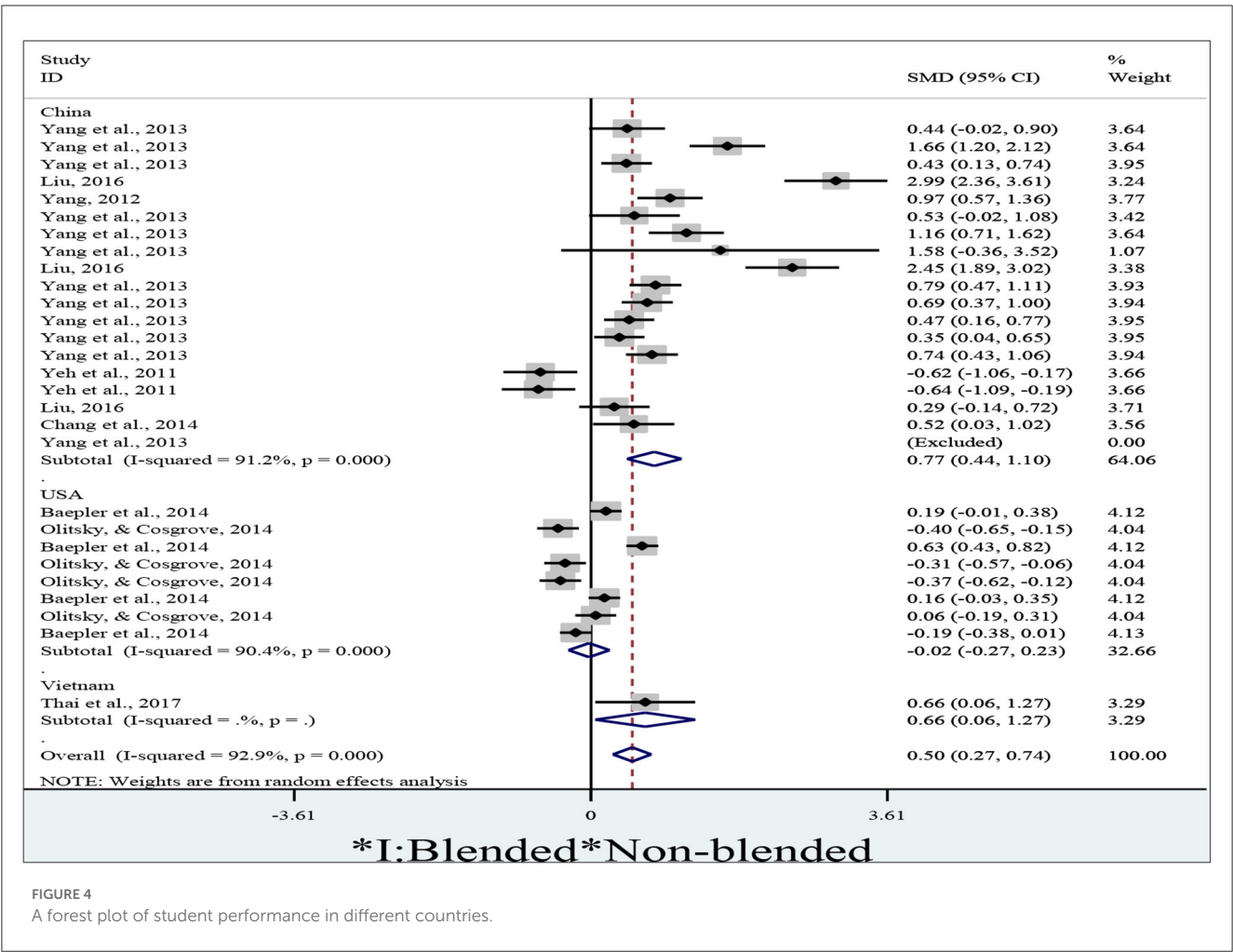
FIGURE 4
A forest plot of student performance in different countries.

attitude toward blended learning). The forest plot will also include a vertical line (often called a diamond) that shows the overall effect size of the meta-analysis, as well as its confidence interval. The forest plot will allow researchers to compare the effect sizes of different studies across countries, providing important insights into how student attitudes toward blended learning vary across different educational contexts. Researchers and policymakers can use these insights to identify which countries have more positive or negative attitudes toward blended learning, and to guide their decisions about educational policy and instructional design.

As shown in Figure 5, students present significantly more positive attitudes in the blended context than in the non-blended in the United Arab Emirates ($d = 1.43$, 95% CI = 0.98~1.88, $z = 6.17$, $p < 0.01$), China ($d = 0.48$, 95% CI = 0.05~0.91, $z = 2.20$, $p = 0.027$), Singapore ($d = 0.32$, 95% CI = 0.18~0.47, $z = 4.37$, $p < 0.01$), Vietnam ($d = 0.43$, 95% CI = 0.01~0.85, $z = 1.98$, $p = 0.047$), the UK ($d = 0.63$, 95% CI = 0.37~0.90, $z = 4.73$, $p < 0.01$), and the USA ($d = 0.98$, 95% CI = 0.78~1.18, $z = 9.41$, $p < 0.01$) since their diamonds are all located to the right of the no-effect line without crossing it. The overall result also indicates that blended learning could give rise to significantly more positive student attitude toward blended learning ($d = 0.59$, 95% CI = 0.37~0.80, $z = 5.28$, $p < 0.01$).

3.5. Can blended learning positively influence learning achievement in different countries?

To identify students' achievements of blended learning in different countries, we extracted 57 effect sizes, where 2 of them sourced from Canada, 13 from China, 22 from Germany, 3 from Spain, 1 from the United Arab Emirates, 1 from the UK, 1 from Vietnam, 14 from the USA. We adopted a random-effect model to implement the meta-analysis due to the high degree of percentage of variability caused by heterogeneity ($I^2 = 87.4\%$, $p < 0.01$). We entered means, standard deviations, and numbers of participants across both groups into Stata/MP 14.0, then we obtained a forest plot after running the meta-analytical program by the variable *country* (Figure 6).

Figure 6, a forest plot of students' achievements in different countries in a meta-analysis, will visually represent the results of multiple studies that examine the academic performance of students in various countries. Each study included in the analysis will be represented by a square on the graph, where the size of the square represents the sample size of the study, and the position on the vertical axis shows the effect size (i.e., the average achievement score) of the study.
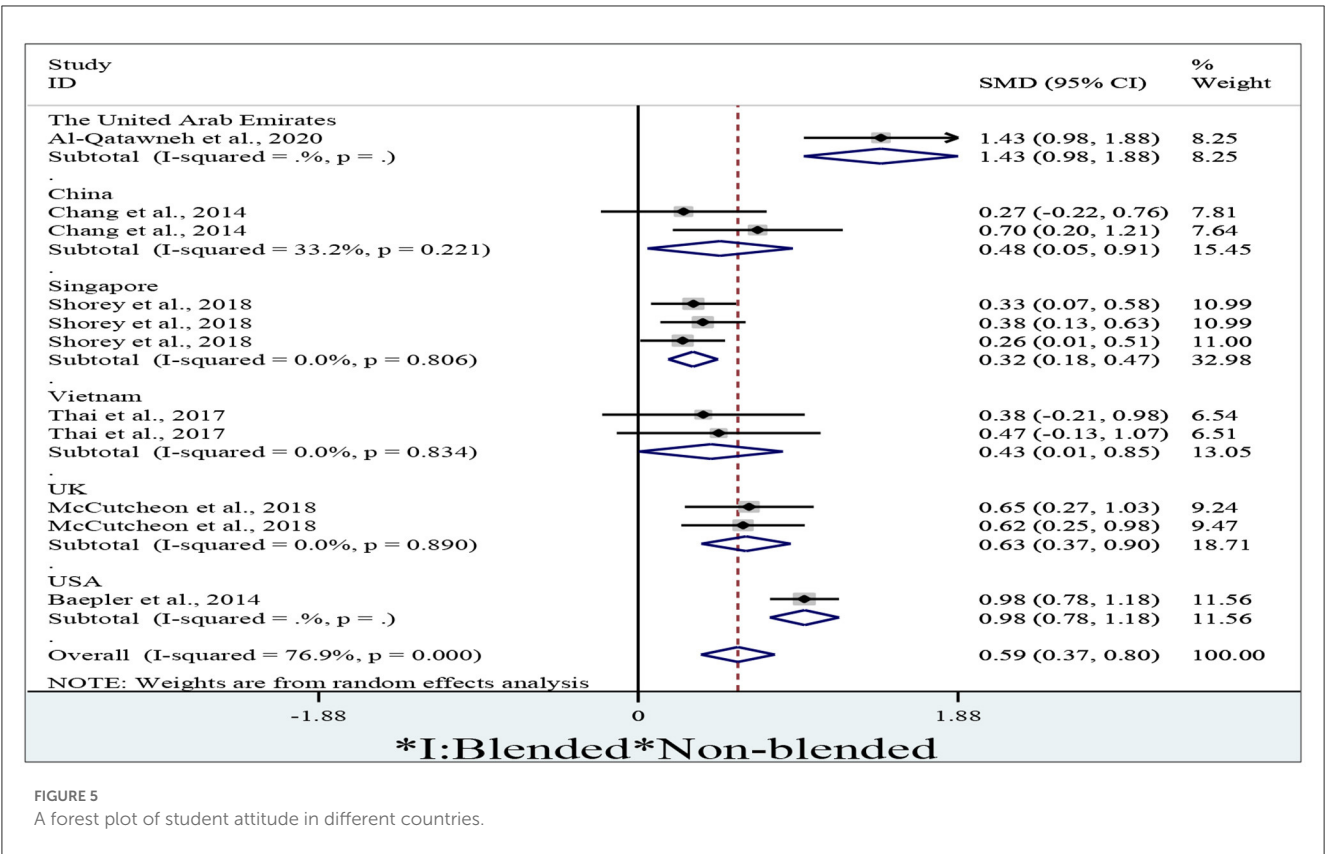
FIGURE 5
A forest plot of student attitude in different countries.

The graph will also include a horizontal line (often called a diamond) that denotes the overall effect size estimate of the meta-analysis, along with its confidence interval. A forest plot of this nature will be useful in comparing the academic performance of students across different countries and regions. Researchers and policymakers can use these insights to gain a better understanding of how student achievement varies across borders, and to identify those countries with higher or lower student achievement scores. This information can guide education policy decisions, such as the allocation of resources and the implementation of targeted interventions to improve student performance.

The pooled diamond at the bottom is located to the right of the no-effect line without crossing it. We thus conclude that the students' overall achievement in the blended learning context is significantly larger than that in the non-blended learning context ($d = 0.30$, 95% CI $= 0.21 \sim 0.40$, $z = 6.24$, $p < 0.01$). No diamonds, the pooled results, for different countries cross the no-effect middle line and all of them are located to the right of it. Consequently, students' blended learning achievements also significantly surpass the non-blended in Canada ($d = 0.53$, 95% CI $= 0.19 \sim 0.86$, $z = 3.07$, $p = 0.002$), China ($d = 0.27$, 95% CI $= 0.15 \sim 0.40$, $z = 4.25$, $p < 0.01$), Germany ($d = 0.15$, 95% CI $= 0.06 \sim 0.25$, $z = 3.13$, $p = 0.002$), Spain ($d = 0.47$, 95% CI $= 0.09 \sim 0.84$, $z = 2.44$, $p = 0.015$), the United Arab Emirates ($d = 1.99$, 95% CI $= 1.50 \sim 2.49$, $z = 7.87$, $p < 0.01$), the UK ($d = 0.47$, 95% CI $= 0.10 \sim 0.84$, $z = 2.46$, $p = 0.014$), Vietnam ($d = 0.65$, 95% CI $= 0.05 \sim 1.26$, $z = 2.11$, $p = 0.035$), and the USA($d = 0.31$, 95% CI $= 0.14 \sim 0.47$, $z = 3.62$, $p < 0.01$). We, therefore, believe that

blended learning could positively influence learning achievement in different countries.

3.6. Can blended learning positively influence student engagement in different countries?

To identify whether the blended approach could improve student engagement in learning, we extracted 14 effect sizes, where 3 of them sourced from the USA, and 11 from China. We adopted a random-effect model to conduct the meta-analysis due to a high degree of percentage of variability of effect sizes caused by heterogeneity ($I^2 = 89.5\%$, $p < 0.01$). After entering means, standard deviations, and numbers of participants of both groups into Stata/MP 14.0, we obtain a forest plot (Figure 7) from the meta-analysis by the variable *country*.

Figure 7, a forest plot of students' engagement in different countries in a meta-analysis, will visually represent the results of multiple studies that examine the levels of engagement of students in different countries. Each study included in the analysis will be represented by a square on the graph, where the size of the square represents the sample size of the study, and the position on the vertical axis shows the effect size (i.e., the average level of engagement) of the study. The graph will also include a horizontal line (often called a diamond) that denotes the overall effect size estimate of the meta-analysis, along with its confidence interval. A forest plot of this nature will be useful in comparing the
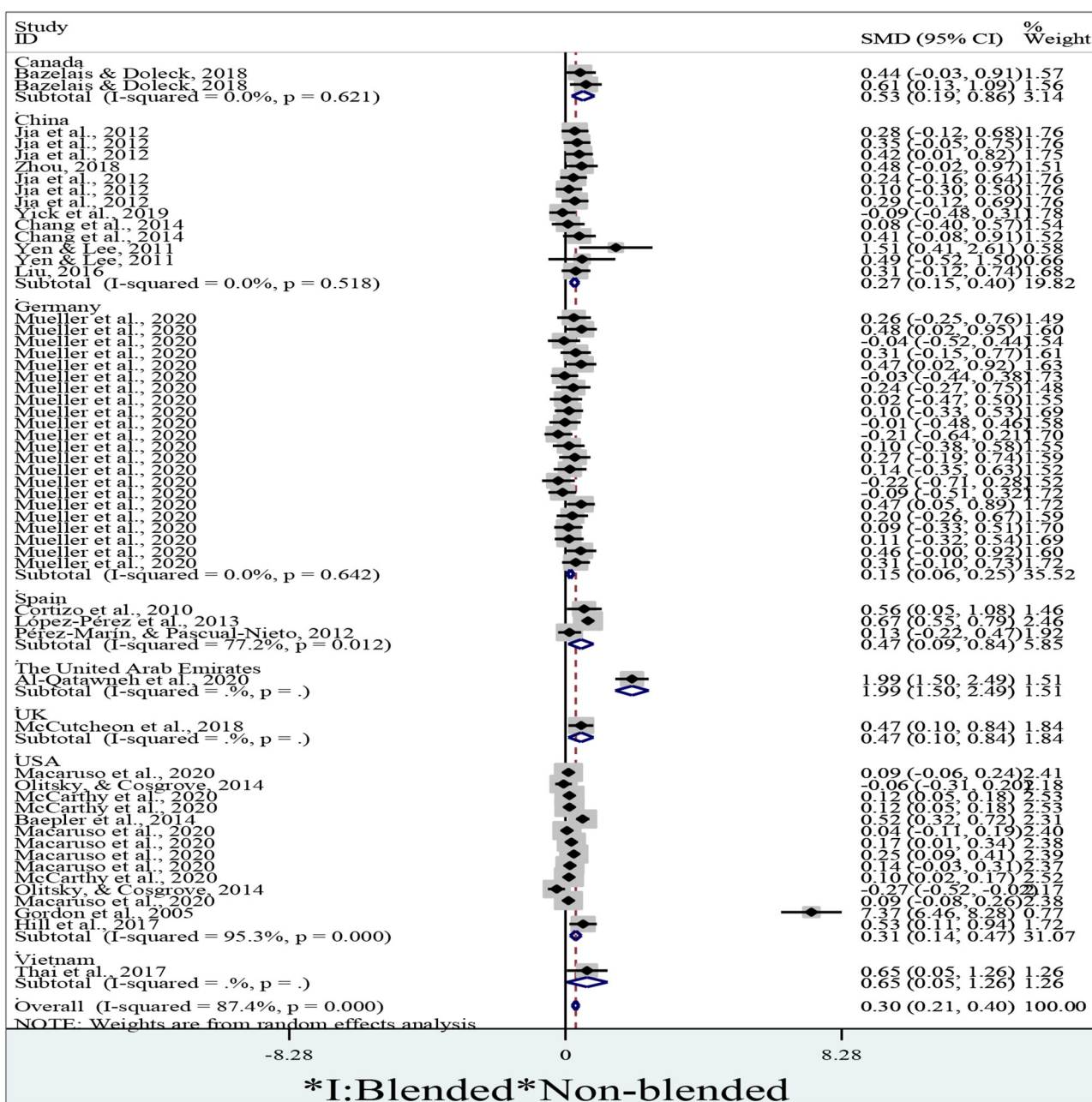
FIGURE 6
A forest plot of students' achievements in different countries.

levels of engagement of students across different countries and regions. It can also be used to identify factors that contribute to higher or lower levels of engagement, such as teaching methods, learning experiences, and cultural factors. This information can guide policymakers and educators in developing interventions that promote higher levels of student engagement, leading to better academic performance and overall wellbeing.

As shown in Figure 7, the diamonds obtained from the meta-analysis of data sourcing from both China and the USA cross the no-effect middle line. The diamond for the overall result also crosses the no-effect middle line. We thus conclude that there are significant differences in student engagement between

blended and non-blended learning in both China ($d = 0.14$, 95% CI $= -0.06 \sim 0.34$, $z = 1.38$, $p = 0.169$), the USA ($d = 0.51$, 95% CI $= -0.35 \sim 1.38$, $z = 1.16$, $p = 0.245$), and the overall results ($d = 0.23$, 95% CI $= -0.09 \sim 0.55$, $z = 1.42$, $p = 0.156$). Therefore, we believe that blended learning could not positively influence student engagement in different countries.

4. Discussion

Blended learning has been found to have a positive impact on student outcomes such as performance, attitude, and learning

FIGURE 7
A forest plot of students' engagement in different countries.
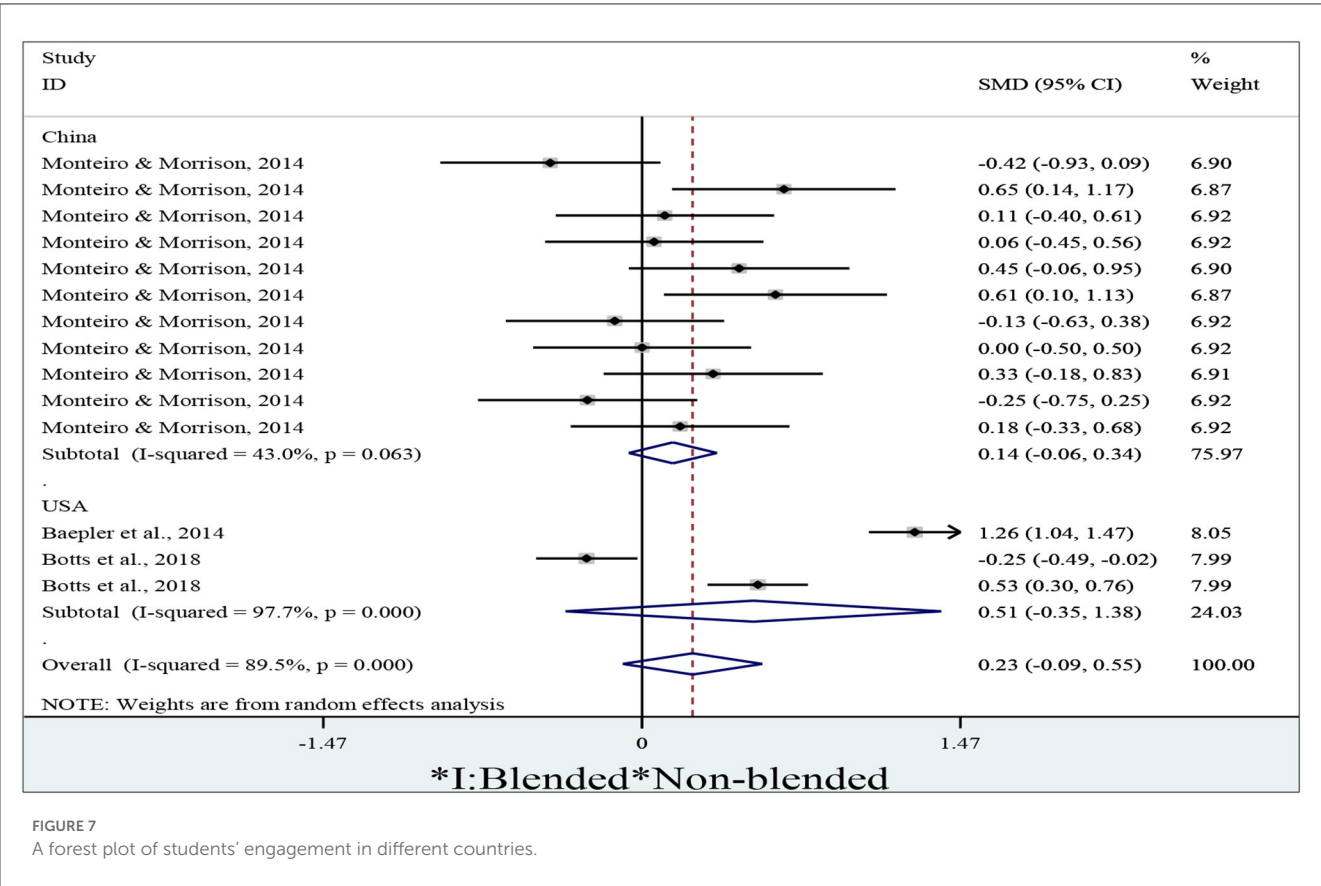
achievement in various countries. This conclusion is supported by the results of previous studies which mostly demonstrate the positive effects of blended learning on these outcomes (Yen and Lee, 2011; Chang et al., 2014). However, it is worth noting that some studies have reported negative effects on student engagement when using a blended learning approach (Botts et al., 2018).

The enhanced student performance observed in blended learning can be attributed to several factors. One crucial factor is that students receive instruction in both physical and online environments. In the classroom setting, students are able to ask questions and interact with their peers and teachers for academic issues. Additionally, they receive more individualized attention from their instructors which encourages them to be more engaged in the learning process. By being asked to answer questions and focus on the course material, students are able to improve their performance (Huang et al., 2022).

Blended learning also provides students with greater access to online resources that they can use to supplement their learning. These resources can include multimedia content, virtual simulations, and interactive quizzes. Consequently, students are able to explore topics more deeply and revisit information whenever they need to. Furthermore, they are able to learn at their own pace and in a location of their choosing, which reduces the burden of travel time and carrying heavy books (Yu and Yi, 2020).

In addition to improving performance and achievement, blended learning has been found to positively impact student attitudes toward learning. The convenience that blended learning offers is a key factor in generating a favorable attitude among students. Students can access learning materials at any time from their device, enabling them to learn wherever they are and at their own pace. This is in contrast to traditional classroom learning where students have to carry heavy textbooks and are restricted to learning only during scheduled class times (Yu et al., 2019).

Moreover, blended learning facilitates online interactions among students, allowing them to work collaboratively, share opinions, and create a supportive learning environment. This enhances the effectiveness of their learning and promotes a positive attitude toward the blended learning approach. The power of the Internet is fully utilized in blended learning to overcome the limitations of physical classrooms, thereby creating a flexible and engaging learning environment that better meets the needs of students. In addition, blended learning integrates formal instruction with informal learning. As a result, students can benefit from both learning contexts and engage with learning materials from various sources. This approach provides them with more learning resources and diverse learning experiences that enrich their knowledge and broaden their perspectives. The seamless linking of formal instruction and informal learning contributes to a student-centered approach to blended learning that enhances attitudes toward learning.

Blended learning has been shown to be an effective method for achieving academic success. The approach requires instructors to make learning materials available via the Internet or a learning platform, enabling students to access content and information at any time. Furthermore, experts and instructors' contact information is made readily available online, allowing

learners to seek further assistance or explore topics in more depth. The benefit of face-to-face interaction in a physical classroom can also be incorporated into the approach. Online courses play a vital role in transmitting learning materials and facilitating communication among learners. This fosters a deeper understanding of course content and strengthens overall comprehension (Yu and Wang, 2016). Moreover, blended learning encourages students to construct their own knowledge and share their insights with others through the Internet. This process encourages creativity and the exchange of ideas, leading to enhanced learning outcomes for students.

Despite the advantages of blended learning, there are potential challenges to learner engagement. Technical issues with online learning platforms can impede students' progress, including unstable system environments, slow computer speeds, and software compatibility problems. Poorly designed menus and interfaces can also cause frustration, as can slow or unreliable internet connections, which limit the ability to multi-task and may ultimately reduce students' enthusiasm for blended learning. These challenges can erode students' confidence in their computer skills, leading to a decline in overall engagement and, in extreme cases, abandonment of the blended learning approach (Sun and Rueda, 2012).

Blended learning can be impacted by the varied backgrounds and experiences of learners, influenced by factors such as geographic location, family background, and prior education. Educational institutions must recognize this and provide training programs to improve students' online technology skills (Bernard et al., 2014). Recorded videos with detailed operation instructions can be especially helpful in bridging gaps in technology skills among students. To ensure that learners from diverse backgrounds can effectively adapt to the blended learning environment, educational departments should regularly implement training programs. This will help students develop the necessary skills to succeed in online learning and overcome any barriers they may face due to their backgrounds and experiences.

Effective curriculum design is essential for increasing engagement in blended learning (Vaughan, 2007). Teachers should leverage the benefits of online learning and integrate them into traditional classroom teaching. Curriculum design must be based on learners' needs and include visual and aural stimuli to enhance engagement. In addition, teachers should work to improve students' self-efficacy, spark their interest in learning, and motivate them to keep engaging with the material to increase their knowledge. Students' strong sense of self-efficacy and satisfaction can drive their voluntary participation in blended instruction and make them more likely to stay engaged throughout the program. One way to improve engagement is to use MOOCs (Massive Open Online Courses) to blend face-to-face courses (de Moura et al., 2021). This approach can increase flexibility and make curriculum content available to learners at any time or place. Ultimately, effective curriculum design, combined with the use of innovative methods like MOOCs, can help increase engagement in blended learning programs and lead to better learning outcomes for students.

5. Conclusion

5.1. Major findings

In this meta-analysis, researchers explored the effectiveness of blended learning compared to traditional, non-blended approaches in various countries. The study focused on key areas such as performance, attitude, achievement, and engagement. Overall, the findings suggested that blended learning can lead to improved performance, attitude, and achievement in many countries. However, when it came to student engagement in academic activities, results from both China and the USA were not significantly different between blended and non-blended learning approaches. Interestingly, in the USA, there were no significant differences in student performance between blended and non-blended learning. While blended learning can produce positive results in many areas, it may not be the best fit for all types of students or settings. Therefore, it is important for educators to carefully consider the needs of their students and the learning environment when determining whether or not to implement a blended approach.

5.2. Limitations

There are several limitations to this study. Firstly, the meta-analysis cannot include all the publications and non-published works due to the limitation of library sources. Secondly, Both Begg's and Egger's tests indicate the presence of publication bias. Thirdly, we cannot completely retrieve the identified research due to various reasons.

5.3. Future research directions

Effective teaching in both blended and non-blended learning environments requires specific instruction that encourages collaboration and practice. This instruction can help students understand the benefits and challenges associated with each approach, ultimately leading to improved learning outcomes (Monteiro and Morrison, 2014). Although blended learning has become increasingly popular in the twenty first century, particularly during the COVID-19 pandemic, research on its effectiveness across different countries is still limited. Future studies can expand this research to examine blended learning approaches in other countries and regions around the world. By exploring the effectiveness of blended learning in a variety of contexts, educators can gain valuable insights and improve teaching practices to better meet the needs of their students. It is essential to conduct this research to ensure that students receive the best possible educational experience regardless of their location or circumstances.

Data availability statement

Author contributions

WC: designed, wrote, revised, and proofread this article.

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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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Supplementary material

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The transformative cognition of English as a Foreign Language student teachers' personal practical knowledge

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This study investigates the process by which English as a Foreign Language (EFL) student teachers transmute their Pedagogical Content Knowledge (PCK) into Personal Practical Knowledge (PPK) within a blended learning community. Data sources, including conversation transcripts, reflective journals, and field notes, were meticulously examined utilizing the commonplaces of temporality, sociality, and place. Several key findings were unveiled: (1) the volume and focal points of transformed PPK varied across participants; (2) the metamorphosis of PCK into PPK was found to be selectively partial, filtered by factors such as previous learning experiences, course expectations, and levels of engagement; and (3) the selection process was molded within the dynamic interplay of the internal components of the blended learning community and the external socio-cultural conditions. The study concludes that the cognition mechanism of EFL student teachers' PPK is characterized by elements of variation, selection, and dynamism.

KEYWORDS

practical knowledge, transformative cognition, blended learning community, filter mechanism, course expectation types, dynamic interaction

1. Introduction

The personal practical knowledge (PPK) of teachers, both pre-service and in-service, significantly influences their teaching practice (Connelly et al., 1997; Johnson and Golombek, 2002; Schaefer and Clandinin, 2018; Clandinin, 2019; Wiens et al., 2022). Certain forms of PPK can foster positive professional development by informing pedagogical theories, while others may introduce bias against alternative perspectives (Nunan, 1992; Tsang, 2004). PPK embodies the knowledge and beliefs authentically implemented in education and teaching (Meijer et al., 2001; Chen, 2011, p. 59), representing "a moral, affective, and aesthetic way of knowing life's educational situations" (Clandinin et al., 2016). As pre-service teachers primarily engage with theoretical pedagogical content knowledge (PCK), it becomes essential to investigate the development and transformation of PPK within such contexts (Wieser, 2016). Specifically, the process of converting theoretical PCK into sustainable PPK warrants exploration.

The impetus for this study is a "blended learning" reform initiative led by an English as a Foreign Language (EFL) teacher-educator researcher. The creation of a blended learning community aimed to provide a broader and more profound platform for student teachers to delve into English pedagogical knowledge, articulate their understandings, and connect their theoretical knowledge with personal experience. This blended learning approach integrated "educator's lecturing + student teachers' group presentation+ team microteaching + cloud interaction".

This research aims to examine how EFL student teachers, within the blended learning community, transmute PCK into their PPK. Theoretical and practical implications are inherent in understanding how PCK is transformed and assimilated into pre-service teachers' PPK, particularly in relation to their personal experiences.

2. Literature review

2.1. PPK transformation and development

PCK is characterized as the foundational theoretical comprehension within a teacher's specific domain, providing the underpinnings of a teacher's instructional expertise (Shulman, 1987; Meijer et al., 1999). In contrast, PPK is defined as a teacher's cognizance of the pedagogical strategies they employ, their mastery of subject-specific terminology, and their convictions regarding teaching and learning (Clandinin et al., 2016; Clandinin, 2019; Wei et al., 2023). PPK encompasses a teacher's knowledge and beliefs about their instructional practices, their understanding of the disciplines they impart, their insights about their students, and their comprehension of their professional and personal contexts. The distinction between PCK and PPK was initially highlighted as a divergence by Dewey in 1904 (Úcar, 2022), signifying the nuanced differences between these two interrelated facets of pedagogical knowledge.

The intersection of PCK and PPK has become a critical area of focus in understanding effective teaching and pre-service teacher education. Both PCK and PPK are instrumental in shaping various aspects of teaching, such as bridging theory and practice, addressing teaching dilemmas, enhancing adaptive expertise, and updating teaching styles (Roblin et al., 2014; Chen et al., 2017; Männikkö and Husu, 2019; Chaharbashloo et al., 2020).

Recent empirical studies have underscored the importance of developing student teachers' PPK before they embark on their teaching careers (Maaranen et al., 2016; Debreli, 2019; Allas et al., 2020; Chaharbashloo et al., 2020). However, there is a paucity of research exploring the transformation process of PCK into PPK and the acquisition of PPK components.

In their research, Žáčok et al. (2020) contend that both theoretical knowledge and practical skills are necessary. They conclude a reciprocal and interdependent relationship between theoretical and practical knowledge, wherein theoretical knowledge provides a foundation and context for practical knowledge, and practical knowledge enables the application of theoretical knowledge in real-world situations with a focus on variation and innovation. Schiller and Zander (2023) similarly found that while PCK forms a common knowledge base shared by teachers, it is the individual teacher's PPK, built upon this shared PCK and shaped by personal experience, that creates different interpretations of the teaching content.

Echoing these sentiments, Wolmarans (2022) argues that practical knowledge, in professional education and practice, is not merely an application of theoretical knowledge. It provides specialized, contextually-embedded knowledge needed to solve real-world professional problems. Some of this practical knowledge transforms from theoretical knowledge, while the rest originates from the professional's past exposure to their profession's nuances.

In the context of vocational education, Wildeman et al. (2023) found a significant difference in teachers' PPK. This divergence was attributed to two factors: teachers' limited reliance on their PCK in teaching and the significant influence of their personal beliefs about teaching and learning on the transformation from PCK to PPK.

Wei et al. (2023) found that the development of practical knowledge in teachers requires facilitation through "formative interventions", which involve deliberate and systematic actions that disrupt usual processes in teacher education, allowing teachers to reflect on their practices and build practical knowledge. These interventions enable the integration of PCK and PPK in teacher education. Úcar (2022) adds a broader context by asserting that both theoretical and practical knowledge are inseparable and vital in pedagogy. The development of these knowledge types involves a complex interplay across three levels: research, integration, and relational. The transformation of PPK from PCK, according to his study, is greatly influenced by all participants in the blended learning community.

The literature reviewed above clearly indicate that the relationship between PCK and PPK is multifaceted and influenced by a range of factors, including individual experiences, professional exposure, personal beliefs, and the collective learning community. The transformation from PCK to PPK is not a straightforward process but requires deliberate intervention and is significantly influenced by both personal and collective aspects.

The transformation between PCK and PPK can be interpreted from two perspectives: the integration view and the difference view (Wieser, 2016). The integration view posits a continuum where PCK can evolve into PPK in practice. Conversely, the difference view suggests a fundamental distinction between the two, where PPK can be transformed into PCK when brought into focal awareness. However, the integration view cannot fully explain instances where teacher education programs fail to achieve their goals due to a divergence between PCK and PPK (Wieser, 2016). Similarly, the difference view falls short in explaining the process of transforming theoretical knowledge into PPK.

Research on PPK has predominantly focused on in-service and experienced teachers, with less attention given to student teachers (Wei et al., 2023). Existing studies primarily aim at diagnosing rather than understanding PPK cognition and transformation.

Several studies have attempted to identify specific strategies and activities to facilitate the transformation from theoretical knowledge to PPK in teacher education. Allas et al. (2020) suggested that video-based reflection can aid student teachers in gaining new insights into PPK, but the relationship between these new insights and their acquired PCK remains unexplored. Similarly, Debreli (2019) found shadowing techniques effective for PPK enhancement, yet the process underlying this enhancement remains unclear. Concept mapping was useful in raising student teachers' awareness of acquired PCK and developing PPK (Wei and Lu, 2022), but the mechanisms behind this process and the restraining contextual elements in the learning community are still unclear. As Cain (2015, p.497) aptly noted, "the empirical literature around knowledge transformation is thin and recent empirical studies continually struggle to illustrate how knowledge transformation takes place".

Úcar (2022) asserts that both types of knowledge are crucial in pedagogy and their development involves a complex interplay at the research, integration, and relational levels. The research level involves

the production of theoretical knowledge, the integration level involves the amalgamation of theoretical and practical knowledge, and the relational level involves the knowledge that emerges from the educator-participant relationship. In this context, PCK aligns with the integration level and PPK the relational level, suggesting that the transformation of PCK to PPK is a complex process shaped by all participants in the blended learning community.

2.2. PPK development in learning communities

Knowledge communities play a crucial role in refining teachers' PPK, thereby fostering professional and identity development. The expansive learning theory underscores the significance of PPK development through collaborative practice within learning communities and proposes an open-ended cycle of PPK learning (Engeström, 2015; Engeström and Sannino, 2021; Wei et al., 2023). This cycle, encompassing seven stages, provides a framework for understanding how PPK is cognized and how student teachers' PCK is examined and transformed into PPK within the context of blended learning communities.

Several studies demonstrate the transformative potential of learning communities. Li et al. (2019) reported that an online teacher community in China facilitated the integration of personal and professional identities. Similarly, Morton and Gray (2010) found that a shared lesson planning conference fostered the effective development of pre-service English teachers' PPK. Craig (2013, 2014) and Li and Craig (2019) documented the construction and reconstruction of veteran Chinese teachers' and beginning American teachers' PPK and identities within online learning communities. These findings suggest that teachers' PPK can emerge and be reconstructed within learning communities.

As participants in the learning community evolve from sharing theoretical knowledge to exchanging personal narratives (Sarasa, 2015), a shared understanding bridges theory and practice, facilitating the development of PPK. PPK development models, such as those proposed by Nasri et al. (2023) and Mansfield (2023), highlight the effectiveness of partnership, reflective pedagogy, and teacher learning in bridging PCK and PPK within blended learning communities. They concur on the necessity of facilitative interventions in PPK transformation within learning communities, termed as "formative intervention" (Wei et al., 2023).

Despite the theoretical and empirical research on knowledge transformation and PPK development within knowledge communities, there is a need for further focused inquiries into the transformation of PCK into PPK within blended learning communities, particularly in the context of the contemporary information age. This is the focus of the present inquiry.

3. Research methods

3.1. Research context and questions

This investigation is grounded in the EFL pedagogy course for third-year student teachers in a normal university, where a blended learning community was created to address time and space limitations

inherent in the course. The community comprised four modules: an introduction to dominant ELT approaches and L2 acquisition theories by the teacher educator, group presentations where student teachers expounded on their PCK on specified ELT topics, team microteaching sessions where teams practiced teaching different lesson types using high school textbooks, and cloud sharing and discussions. The first three modules were conducted offline, while the fourth module ran concurrently with the other modules throughout the semester. Offline lessons ended with discussions, which then continued online. Students were mandated to share their reflective journals, respond to the teacher educator's class observation notes, and engage with their peers' journals online. Their performance in group presentations, team microteachings, and online learning engagement was used for evaluation purposes.

The overarching goal of this study is to discern the mechanism by which EFL student teachers transform their acquired PCK into PPK. The study focuses on the following research questions:

1. What PCK have the student teachers acquired?
2. How do individual student teachers transform this PCK into their PPK?
3. How does the blended learning community facilitate the transformation of PPK?

3.2. Participants

The participants were three student teachers from the course with diverse learning experiences and academic backgrounds, none of whom had teaching experience prior to joining the blended learning community. The participants were Ting, who graduated from a distinguished provincial middle school in Southwest China, Qian from a regular middle school in Central China, and Yue from a distinguished provincial middle school in Central China.

Ting and Qian had similar learning experiences in their middle school English classes, characterized by a focus on vocabulary and grammar, traditional lectures, and a teaching model adhering to the "presentation – drills – written exercise" sequence. Their classes were dominated by teacher-led deductive presentations with minimal variety in activities. The students followed a passive "receiving" role, and the classes' effectiveness was contingent on the students' motivation to learn and their ability to follow the teachers' presentations. A minor difference between Ting and Qian's experiences was that Qian's received instruction focused solely on vocabulary and grammar, while Ting's included listening training in a test-like format.

Contrarily, Yue's experience was markedly different, featuring a teaching model of "picking up the model language – recite – written and oral practice," diversified teaching and learning activities of both oral and written practice and games, and a learning mode of "note-taking – oral and written practice," in both individual and collaborative forms.

3.3. Data collection and analysis

The research adopted a field-based qualitative methodology, situated within the context of a blended learning community

specifically designed for a course in EFL pedagogy, under the instruction of the first author of this paper. A multi-source, qualitative data collection approach—both offline and online—was utilized throughout the course's progression. This data was then meticulously analyzed on a thematic basis, with a particular emphasis on the transformation of PCK into PPK.

The use of field-based data collection was deemed appropriate for the objectives of our study for a couple of reasons. Firstly, the development of PPK is understood to occur within field practice, as suggested by Mansfield (2023) and Wei et al. (2023). Secondly, field-based data offers an authentic representation of teachers' PPK development within their regular teaching practice, thus providing intrinsic value to our analysis. We employed a thematic data analysis methodology to deeply explore how PCK is gradually transformed into PPK, and to elucidate the role of the blended learning community in facilitating this transformation.

Data were collected throughout the semester within the blended learning community, covering both offline and online activities. The data types included class observation notes on the student teacher participants' performance in presentations and microteachings, interviews with the participants, participants' lesson plans, and their reflective journals and feedback on peers' journals shared on the cloud platform. The data collected were qualitative. The data were gathered through a concurrent and triangulated methodology. This approach ensures a comprehensive and robust data collection process. Each type of data, providing a holistic and complementary perspective, is systematically utilized to address the three intricately linked research questions of this study.

The data were subject to thematic analysis, oriented by the three-dimensional commonplaces: temporality, sociality, and place, as outlined by Clandinin (2019, 2023) and Clandinin et al. (2016). Temporality, denoting "temporal transitions," directs our focus towards the evolution of learners' PPK by establishing connections between past, present, and future experiences. Sociality, representing "social milieus," enables us to observe the development of learners' PPK by associating personal conditions with the broader social context. Place, referring to "geographic locations," permits us to scrutinize learners' PPK development within specific contexts, such as the blended learning community examined in this study.

In this study, or temporality, data were analyzed to understand how participants' English pedagogical PPK and understandings evolved over the semester. Participants' pedagogical beliefs and PPK prior to the course, as well as their plans for future teaching, were also considered.

Under sociality, personal factors such as "feelings, hopes, desires, aesthetic reactions, and moral dispositions" (Clandinin, 2023) were considered to understand how personal narratives influenced participants' PPK and understandings about effective and useful EFL pedagogy. The impact of middle school teachers, peers, and the current course instructor on participants' prior PPK, and how these interactions influenced their academic life, was also analyzed. Attention was given to how feedback from external environments interacted with participants' idealistic beliefs about English pedagogy, that is, the "world travel" between personal and social worlds (Clandinin, 2023).

In terms of place, data were analyzed to examine the mechanism of PPK transformation within the specific context of the blended learning community as "the specific concrete boundary of inquiry"

(Clandinin et al., 2016) Meanwhile, data were also analyzed to examine how the blended community facilitated the participants' PPK transformation.

4. Results

The pedagogical journeys of the three student teachers intersected in a single classroom, under the guidance of the same teacher educator. As they project their paths into the future of teaching, a sense of uncertainty and potential for growth is evident (Clandinin, 2023). However, reflecting on their past (Clandinin, 2023), it becomes apparent that their routes to this point have been diverse. They have encountered a variety of teachers and have differing experiences with prior English learning. These differences have significantly shaped their acquisition of PCK and their transformation of PPK.

4.1. Acquisition of PCK within the blended learning community

All three participants expressed that they had developed PCK, both in terms of underlying conceptual beliefs and in the design of teaching procedures and activities for various lesson types. As evidenced in their reflective dialogues, they attributed their progress to the collaborative learning activities offered in the course, particularly microteaching (Ting and Yue), peer journal review (Qian), and group presentations (Qian).

Ting noted, "In this course, I absorbed innovative teaching methodologies, strategies and the theories that underpin them, and was granted the opportunity to apply these during micro-teaching sessions" (Ting, reflective journal). Qian reflected on the variances in understanding and approaches to teaching, gained from offline microteaching and online journal reviews, stating, "I acquired theoretical knowledge from you and classmates' group presentations…, offering me a broader perspective on effective teaching methods and activities. At the meantime, in both offline and online collaborative sharing and learning helped me realize that it was common and normal that we student teachers had different understandings and perspectives about the best ways and activities of teaching." (Qian, reflective journal). Yue appreciated the practical application and interaction provided by online discussions and offline microteachings, noting, "These opportunities allowed us to deepen our understanding and apply what we learned" (Yue, reflective journal).

While the three participants collectively enhanced their PCK, their individual learning engagements, expectations, and focuses varied, leading to unique learning outcomes within the blended community.

For Ting, the course was an exploration of teaching theories and the rationale behind teaching methodologies. She expected to understand the teaching styles of her previous instructors and their underlying motivations, stating in the interview "to learn the way my former school teachers employed and understand why they taught in that way" (Ting, interview). In the blended learning community, she gained insights into novel teaching designs and their theoretical foundations, surpassing the pedagogy employed by her middle school English teachers. She was particularly struck by the significance of proper classroom teaching objectives and scaffolding activities, which clarified the relationship between teaching objectives and activities. As reflected on her own teaching design, she wrote "I was suddenly enlightened when Professor

X analyzed the objectives in my teaching plan" (Ting, reflective journal). Moreover, she realized the necessity of pre-listening and pre-reading activities, a shift from her previous middle-school English learning experience. She narrated in the interview, "In my memory and original understanding, that kind of activities did not exist as my school teachers never employed them, and they just provided us with learning materials and asked us to answer questions directly. In this course, I learned that it was necessary to prepare scaffolds for students before they were required to do a task" (Ting, Interview).

Qian, on the other hand, confronted her entrenched belief in traditional "duck-feeding" methods through differing perspectives on specific teaching issues. Her goal was to acquire both pedagogical knowledge and teaching skills. The course provided a platform for her to meet these expectations by engaging with her peers and receiving feedback from the teacher, thereby promoting her understanding of English teaching. She wrote "I learned a lot from the professor's feedback as it is focused on what we need to change and improve. We spend much time to figure out the answers to professor's questions by discussions and searching for academic papers" (Qian, reflective journal). While learning alongside her classmates and teammates, she kept individual and independent thinking. As reflected by her, "we had a lot of face to face and online discussions, even argues. I also read classmates' online journals. In those discussions and journals, I learned different perspectives in understanding teaching…. But I have been uncertain about the effectiveness of those new teaching ideals and methods, as I have never experience them in my school English learning" (Qian, interview).

Yue found value in the wide range of teaching activities available in the community and developed a deeper understanding of teaching reading. Her educational background had already exposed her to innovative teaching designs, thus this course served as a continuation of her teaching learning journey. Her narrative about reading instruction illustrates her evolving comprehension of lesson planning and the flexibility required in teaching. "I had no idea about how to write a reading lesson plan when we were supposed to do that in the Public Pedagogy course I took last semester. Then I found the general "pre-while-post reading" framework from the internet. Later on, when we did the group presentation in this course, I began to acknowledge that different stage of a reading lesson should be realized by different activities…. When we did the microteaching, I realized that the activities should not be fixed, and they should be chosen and arranged flexibly to serve the objectives of different teaching steps respectively" (Yue, interview).

The disparity in learning outcomes suggests that while Ting and Qian primarily focused on gaining PCK, their learning was concentrated on pedagogical knowledge acquisition and understanding. In contrast, Yue placed greater emphasis on applying knowledge in lesson planning and microteaching, thereby transitioning part of her theoretical PCK into her PPK. A comparative analysis of the three participants reveals a connection between their past educational experiences, course expectations, and learning outcomes, which will be further explored in the discussion section.

4.2. Transformation from PCK to PPK

PCK can be either theoretical or practical (Úcar, 2022). However, it does not evolve into the student teachers' PPK until it has undergone

transformation. In this transformation process, some aspects of PCK are embraced, while others are disregarded or neglected. The mechanisms through which acceptance or rejection occurs are distinct for each individual, as demonstrated by the three pre-service teacher participants in our study.

Ting's learning primarily focused on the design, arrangement, and functionality of English teaching activities. She first familiarized herself with the activities relevant to different types of lessons. Subsequently, she evaluated their strengths and weaknesses, drawing on both the accompanying lecture materials and her personal experiences. Ultimately, she concluded that the purpose of teaching activities is to facilitate the achievement of teaching objectives. As she narrated, "I got familiar with some teaching activities first in the course, for example, …. Later, I came to understand the functions of various teaching activities, along with their strengths and weaknesses in the presentations and discussions. My current understanding is that the design and arrangement of activities should be oriented towards achieving the teaching objectives of different steps" (Ting, interview).

Ting recognized and accepted the teaching methodology characterized by student-centered activities and tasks, as advocated by the teacher educator. She expressed her intention to incorporate these methods and activities into her future teaching in the interview, "I am going to use them in my future teaching." However, she also expressed concerns about acceptance and understanding from her future professional community, as the student-centered teaching approach contradicted her familiar school learning experiences. She narrated in the interview, "I think it is important to reach the school and parents and obtain their acceptance if we want to make some change in teaching" (Ting, interview, reflective journal).

Qian's experience of accepting PCK and transforming it into her PPK was unique. Most of the PCK she acquired was entirely new and conflicted with her previous school learning experiences, leading her to "feel uncertain and even resistant" (Class observation notes). Her transformation process was marked by tension, conflict, doubts, and instability. Initially, she rejected the course's advocacy for students to learn English through various activities and tasks, as it contrasted starkly with her experience of teacher-led learning. Qian initially viewed these activities as mere "trimmings." The tension and resistance in Qian's new PCK acquisition and PPK transformation were reflected in the interview, "My school English teachers used traditional teacher presentation-dominated teaching method. They scarcely employed activities in class. I think activities are just external packings in teaching. Why should we bother with those packings?… The direct presentation and explanation were clear and efficient. Some students, like me, prefer teacher's direct teaching of language points and did not want to do those activities. But for other students, the sole presentation and explanation mode might be too boring…." (Qian, interview).

However, over time, Qian's understanding evolved. She came to appreciate the integration of various teaching activities, as she gradually understood that the integration of various teaching activities and teaching content were different from the traditional teaching not only in their superficial appearance, but also in their function and effectiveness, as narrated in the interview, "though I thought the activities are just outer packings, the employment of them in teaching does have effects. The sole teacher's presentation is limited in its effectiveness. In microteaching, some of my classmates designed and used various activities very well, the teaching effects were good. So now I do not think those activities are just non-compulsory time-consuming

packings. Idealistically, students should love them" (Qian, interview). But the hesitation and reluctance in the interview showed that Qian' acceptance of the newly acquired PCK was not without reservation, and the new teaching methods and ideals had not been transformed into her PPK as she was still doubtful about their feasibility. Bearing doubts, she did not completely reject them either. The tension and uncertainty between understanding and acceptance were obvious, due to the conflict between her former familiar school learning experience and the advocacy in the course as well as the positive effect of her peer's practice in microteaching. She stated, "Maybe I will try them out when I become a teacher in future to see if they really work to my students, but right now I'm still not sure as personally I did not have that experience after all in my middle school English learning (Qian, interview).

Yue's learning experience in the course emphasized that language skills and strategies should be both explicitly and implicitly taught and trained in various types of lessons. This contrasted with her prior school English learning experience, which emphasized memorizing and accumulating model language expressions. Despite this discrepancy, Yue was receptive to the new approach and acknowledged the importance of strategy teaching. She intends to include language skills training and strategies in her future teaching, as she narrated, "I think we should put what we learned in this course in use in middle school English teaching, for example, to teach how to read. Those strategies and skills need to be taught in class because students need them. I'm going to employ them in my future teaching" (Yue, interview).

In Yue's case, the new theoretical PCK she acquired in the blended community has been transformed into her PPK. This successful transformation may be partially attributable to her deep and comprehensive understanding of the new theoretical knowledge, and partially to her recognition of her deficiencies in certain language skills and the necessity of their inclusion in school English teaching. As indicated in the interview, "I spent a lot of time on learning reading teaching in this course. The more I know, the more I realize the importance of reading skills and strategies in teaching. I was not good at listening and could not get a fair understanding in listening class at the beginning stage of my college. I felt anxious but no one helped me with that, and my middle school teachers did not train it either." (Yue, interview).

4.3. The role of the blended community in facilitating transformation

The narratives and reflections of Ting, Qian, and Yue reveal that their transformation of theoretical (PCK) into PPK is influenced not only by their prior experiences, but also by the milieu wherein they interact with others. This milieu has been referred to as the "professional knowledge landscape" (Clandinin, 2023), "interactive context," or "community of truth" (Palmer, 1998). In the context of this study, the transformative environment is the blended learning community established for the ELT Pedagogy course.

The blended community functions as a conduit for transformation, fostering an expansive and profound platform for collaborative learning and mentoring. This platform evolves as a multifaceted dynamic system, spawning opportunities for learners to transform theoretical knowledge into personalized PPK. The constituents of this complex system include student teachers, the teacher educator, the physical classroom, the cloud-based platform, the theoretical PCK imparted during lectures, educator's

observational notes and comments, student teachers' shared ideas, lesson plans, reflective journals, both offline and online comments, co-built resources, and the interactional dynamics among these elements.

The blended community catalyzes knowledge transformation in two principal ways. Firstly, peer sharing and discussions deepen the understanding of PCK among student teachers. Most online journals focus on specific topics. "Coupled with peer responses, they offer a rich resource for learners to explore unfamiliar territories" (Class observation notes). As Ting reflected, "I gleaned substantial knowledge from my classmates' cloud-based journals. Some of their ideas remain novel to me even as we near the end of the course" (Ting, reflective journal).

Secondly, the blended community extends the boundaries of PCK beyond the confines of the teacher educator's delivery, thereby "broadening the scope and viewpoint" (Class observation notes). The diversity of ideas and resources, both within and outside the classroom, enable student teachers to decode PCK from multiple angles, referencing varied application contexts. As reflected in their conversations, "By reviewing your class observation notes and comments shared on the cloud, I discovered aspects and details of teaching that I had overlooked but you had noted… I believe my reflections and thoughts, triggered by my classmates' journals or comments, are beneficial as they prompt me to think more and understand more deeply" (Qian, interview). "One of Y's journals focused on 'continuation writing'. I was unfamiliar with it and intrigued to learn more. My exploration led me to understand the necessity of bridging reading with writing in teaching… My classmates' online discussions prompted me to reassess my understanding and adopt a different perspective" (Yue, interview).

The blended learning community nurtures critical thinking among student teachers regarding their previous learning experiences and facilitates the contextualization of PCK. It offers opportunities for the collation, cross-checking, reflection, and transformation of varied understandings of PCK based on individual experiential backgrounds. The breadth and depth of theoretical PCK are interpreted and accepted differently by each student teacher, as expressed in their journals and feedback. The tensions between the student teachers' prior English learning experiences and their peers' and their own understandings stimulate reflection and further inquiry, driving forward their ongoing knowledge transformation and PPK development. The potency of this transformative mechanism is reflected in the participants' reflections. "I find professor's offline and online comments invaluable in understanding and evaluating our former school teachers' teaching and classmates' microteaching…. The journals and feedback are equally beneficial as they provoke us to reflect on our own interpretations and learn from our classmates" (Ting, reflective journal). "During the microteaching session, I was oblivious to some of the innovative designs of other teams until I read professor's comments and those of my classmates. This prompted me to recall the details, understand their nuances and the rationale behind them, and contemplate on how I could incorporate them into my teaching" (Yue, reflective journal).

5. Discussion

5.1. Selective transformative cognition of PPK

As evidence from the preceding section suggests, the participants have demonstrated a partial and selective assimilation of the principles

and practices introduced in the course. Such selective transformation from theoretical PCK to their PPK is significantly influenced by their learning expectations and prior experiences.

When observed collectively, the transformation from PCK to PPK amongst the three participants is uniformly selective and partial. This selective transformation is governed by the interplay of their previous learning experiences, course expectations, and engagement in learning. The dynamics of these factors determine the types of PCK likely to be transformed into PPK.

Examined individually, each student teacher's transformed PPK concentrates on different facets of PCK. Their learning expectations differ, and thus the magnitude and breadth of transformation also vary. This transformation is conditioned by distinct modes of interaction within the learning community.

Ting's expectations, which are vaguely oriented towards understanding her previous English learning experience, can be classified as 'backward-looking' expectations. These expectations did not provide a potent motivation for engagement in learning innovative teaching methods in the course. This is reflected in her relatively passive classroom performance and involvement in the blended learning community. Ting's transformed PPK primarily encompasses understanding and evaluating the teaching methods employed by her school English teachers. The transformation is selectively partial, given her limited 'backward-looking' expectations and lack of strong learning motivations.

Qian's PPK transformation primarily focuses on teaching skills and her own experience in group presentations and team micro-teaching. She hoped to acquire specific teaching skills and observe how the educator presents PCK. Her "present-sitting" expectations, focusing on PPK development and personal experience in experimenting with teaching skills, provided her with moderate motivation to learn new pedagogical knowledge. Qian's PPK transformation was tentative, primarily about teaching skills, especially presentation skills. The transformation was selectively partial despite her clear expectations, due to her skepticism about its effectiveness.

Yue expected the course to pave the way to a future teaching career, aiming at acquiring practical teaching skills. With very specific expectations, she actively engaged in the blended learning community by answering questions, initiating discussions, sharing in-depth thematic journals, and providing interactive feedback to peers' comments. Unlike Qian, Yue's middle school English teacher employed diverse teaching activities, which fostered her openness to innovative activities. Yue's transformed PPK primarily included practical teaching skills and activities. Despite her clear 'forward-looking' expectations and uninhibited by prior learning experiences, Yue's transformation of PCK into PPK was still selectively partial, as it was confined by the scope of her expectations.

Swart et al. (2018) posited that language teachers' PPK "originates from their professional practice and is based on their past experience, current awareness, and future expectation." The findings of the present inquiry substantiate their argument. The past experience herein includes the prior school English learning experience, current awareness can be interpreted as the PCK acquired in the blended community, while future expectation can be interpreted as course expectations.

As discussed above, clear and specific expectations stimulate learners' engagement, and the scope of these expectations directs its

focus. However, the nature of learning expectations and the degree of learning engagement do not necessarily correspond to the extent and depth of PPK transformation. This is because it is conditioned and filtered by the learners' prior experiences, as exemplified in Qian's case.

This selective process results in the diversity and difference in student teachers' PPK development, echoing findings from previous research. Both qualitative (Meijer et al., 1999) and quantitative studies (Meijer et al., 2001) found that while there was shared knowledge among teachers, a wide diversity and significant difference existed in their PPK regarding teaching reading comprehension.

Aside from course expectations, the selective transformation of PPK from PCK among student teachers can also be attributed to agent differences in knowledge production (Úcar, 2022). While PCK can be a result of individual or collective integration, PPK arises primarily from singular relationships. The PCK acquired by student teachers is collectively provided by the teacher educator in the course.

When PCK is transformed into PPK, a process of "functionally asymmetric negotiation" occurs (Úcar, 2022). This negotiation takes place among various entities: between the teacher educator and individual student teachers, among the student teachers themselves, and between an individual's past experience and the newly acquired PCK within the blended learning community. This asymmetric negotiation in the course learning experience may lead to the selective transformation of PPK, as evidenced in previous research (Noroozi et al., 2018; Noroozi, 2022). Consequently, the transformation of PCK into PPK is not a uniform process, but one that varies based on individual experiences and interactions.

5.2. Mechanism of filtering in PPK transformation

The transformation of PCK into PPK is a process that all three participants underwent, albeit with varying degrees of transformation. Crucially, not all theoretical PCK acquired was transformed into their PPK. This transformation process is shaped and filtered by their learning expectations, learning performance, prior experiences, and the beliefs derived from these experiences.

This filtering mechanism is particularly evident in Qian's case. Qian recognized that the PCK advocated in the course differed from the teaching methods of her middle school English teachers. While she acknowledged their alignment with the New Curriculum prescriptions (MOE, 2018) and their relevance for contemporary English teaching pedagogy, she retained skepticism about their effectiveness. Her previous English learning experience, characterized as a "direct duck-feeding" mode, led her to believe that teaching effectiveness is more a result of learners' voluntary engagement rather than teaching methodology. Her personal success in gaining admission to a prestigious university reinforced her belief in the efficacy of traditional teaching methods and fueled her doubts about the feasibility of the innovative teaching methods introduced in the course. Consequently, she attempted to understand them but was reluctant to accept and potentially utilize them in her teaching.

In the journey of transforming PCK into PPK, doubts and uncertainties inevitably emerge due to the gap between prior experiences and newly acquired knowledge. These doubts initiate tensions that create opportunities for knowledge transformation.

Whether this transformation occurs or not is contingent on the individual's willingness and strategies to resolve these tensions.

In contrast to Qian, Yue demonstrated a more open attitude towards the innovative PCK introduced in the course, hence her approach to dealing with the ensuing tensions differed. Both Qian and Yue initially expressed uncertainty about the effectiveness of activity-based teaching introduced in the course, leading to a tension between their prior experiences and the new PCK. However, their strategies for easing this tension diverged. Qian did not actively engage in in-depth discussions to dissolve the tension, whereas Yue attempted to find solutions by actively participating in multiple rounds of discussion and commenting in the blended learning community.

The disparity in learning participation between Qian and Yue correlates with their respective transformations of PPK. PPK, as a teacher's construct, is narratively embodied and practically expressed (Schaefer and Clandinin, 2019a; Talaee et al., 2023). The narrative and practice in this study are derived from the participants' learning experiences within the blended learning community. While there are shared elements in their experiences, such as the PCK provided by the course instructor and class assignments, the learning experiences of each participant are distinct, largely due to their engagement in different collaborative groups. Consequently, their participation within the learning community varies, leading to differences in the content and magnitude of PPK transformation.

The variation in PPK transformation among individual student teachers, such as Qian and Yue, aligns with findings from Golombek (2009) and Xu and Connelly (2009). These studies concluded that teachers' cognition of PPK is accompanied by, and filtered through, their participation in professional development activities. Additionally, the unique participation of each student teacher may involve varying degrees of "interpersonal sensitivity" (Spoel et al., 2020), which can subsequently influence the transformation of their PPK.

The distinct approaches of Qian and Yue in addressing these tensions may be linked to their differing prior learning experiences. Qian, who had succeeded in gaining admission to a key university despite her teachers' exam-focused, "duck-feeding" teaching approach, held a strong belief in this method and was resistant to alternative effective teaching methods. Conversely, Yue's exposure to various learning experiences and diverse classroom activities during her schooling, as well as her experience with "group cooperative inquiry learning," may have developed her ability and mental readiness to answer questions through inquiry. These experiences likely facilitated her open attitude towards the new PCK and her ability to dissolve tensions by embracing them, resulting in a less filtered transformation from PCK to PPK.

The significant influence of prior learning experiences on a teacher's PPK development has been substantiated in various studies. Li (2020) established that PPK is shaped by teachers' experiences within both formal and informal educational spheres, including their personal life experiences. Similarly, Wang et al. (2018) discovered that both pre-service learning and in-service teaching experiences can significantly impact PPK development. Furthermore, Schaik et al. (2018) found that one's academic background can either facilitate or impede the cognition of PPK. These findings collectively underscore the pivotal role of prior learning and experiential contexts in shaping the development and understanding of a teacher's PPK.

Examining across all participants, the filtering mechanism in knowledge transformation is influenced by both internal components

within the learning community and external considerations. The internal components include the participants' and their peers' prior English learning experiences, varying interpretations of these experiences, diverse beliefs about English learning, and differing learning expectations. These internal components create a unique filtering mechanism for each individual, affecting the extent and focus of knowledge transformation. The external factors include the relevance of theoretical PCK to future teaching practice and the evaluation methodologies of future teaching. The former refers to the extent to which theoretical knowledge is directly related to teaching practice. That explains why limited volume of theoretical knowledge on second language acquisition, which is a compulsory session, was transformed into the participants' PPK, as indicated in their reflective journals, comments and interviews. The latter refers to how routine teaching is evaluated in examinations, such as in college entrance exams. That explains why PCK closely related to the content tested in exams was attended to and transformed more into the participants' PPK.

The mechanism that governs the acceptance and transformation of PCK into PPK functions in complex ways. In some scenarios, internal components exert a more significant influence, whereas in others, external factors prevail. The development of a teacher's PPK is the outcome of the interplay between these internal and external components. This is consistent with Huang's (2010) research, which found that EFL teachers' PPK about grammar teaching is shaped by the interaction of multiple sources from their previous experiences as EFL learners and teachers, along with the unique socio-educational context of the EFL setting.

The relationship between prior experience and selective knowledge transformation identified in this study aligns with prior research. Baleghizadeh and Shahri (2014) found that teachers' divergent understandings about English speaking competence and teaching reflect the "interwoven nature of learning experience with teaching conceptions." Schaefer and Clandinin (2019b) discovered that novice teachers' "stories to live by were shaped in their early personal knowledge landscapes and embodied in their PPK." In their study, Ferry et al. (2022) discovered that PPK cognition is significantly shaped by the experiences of student teachers prior to and during their teacher education. Moreover, they highlighted that the acquisition of PCK during teacher education serves as an even more potent influence, exerting a substantial degree of shaping power. However, certain external components can exert a stronger influence on shaping teachers' PPK in a particular socio-educational context, as found in Huang's (2010) study, which demonstrated that teachers exhibited similar classroom grammar teaching practices despite their diverse backgrounds.

The relationship between external components and PPK transformation identified in this study is congruent with previous research. Huang's findings suggest that the socio-educational context in Taiwan can significantly shape EFL teachers' PPK in a similar way (Huang, 2010). Moreover, teaching assessment methods can also influence and shape teachers' selection and PPK development. In Tang's (2010) exploration of teachers' knowledge construction, they found that teachers effectively integrated Assessment for Learning into PCK, transforming it into their PPK as "practicalizing theoretical knowledge," in conjunction with their complex personal prior experiences. This implies that the transformation of PCK into PPK occurs within a particular social context. The predominant form of teaching assessment in that context can shape student teachers' judgement about which PCK knowledge could be useful and feasible,

thereby influencing their acceptance and transformation of this knowledge, while rejecting others. This might account for Qian's reluctance and doubt in accepting the innovative PCK and transforming it into her PPK.

5.3. Dynamic process of PPK development

The findings of this study unveil a dynamic process wherein preservice teachers transform PCK into their PPK. This process involves not a static but an evolving development of PPK. The transformation begins with familiarization with PCK, progresses towards gradual understanding and acceptance, and culminates in the adjustment and revision of the knowledge in practice. This process situates PCK in specific contexts, thereby imbuing its generic features with the characteristics of particular situations. This specification process fuels the dynamic transformation.

The dynamic process of PPK transformation and development manifests in the continuity and interaction of student teachers' experiences within the blended learning community. As Clandinin (2023) posits, continuity and interaction are the two criteria that shape individuals' experiences, which manifest as narratives enacted in specific contexts. PPK emerges from teachers' "stories to live by" (Connelly and Clandinin, 1999) and evolves in the cyclical process of "living," "telling," "retelling," and "reliving" (Clandinin et al., 2016). In this continuous cycle, teachers' understandings of their narratives are persistently evolving. Hence, the transformation from PCK to PPK and the ongoing development of PPK are in a constant state of dynamic change.

This dynamic process is corroborated by both previous empirical research and the present investigation. In a study exploring Taiwanese EFL teachers' beliefs about grammar teaching and PPK, Huang (2010) identified an "ongoing process of change" in cognition and PPK among participants. Similarly, a study by Desrochers (2017) on Canadian preservice teachers' PPK on student diversity found that the teachers came to understand how their PPK had been shaped and could be reconsidered and reshaped in light of new experiences. In the current study, Yue's experience of PPK transformation and further development was accompanied by a dynamic process of knowing, understanding, and flexibly applying knowledge. Prior to this course, Yue was unsure about effective reading teaching methods. During the course, she was introduced to various activities for teaching reading, though initially she did not understand the need to use different activities at different stages. Through interaction in the blended learning community, she came to understand that activities should be chosen and designed flexibly to meet the objectives of different stages. Ultimately, she successfully implemented these activities in team microteaching.

The dynamic nature of PPK transformation and development is closely linked to the learning or working community of the teachers. In the current study, the participants' PPK transformation was guided by the PCK ideals presented and advocated by the teacher educator in the blended learning community. This finding echoes previous research exploring the relationship between teachers' PPK development and its context. For example, studies by Craig and her colleagues found that the PPK of rural Chinese school teachers varied and developed as the test-oriented and professionally challenging environment changed (Li and Craig, 2019; Zhong and Craig, 2020). A

strong connection was found between American school teachers' shifting identities and changing school landscapes, with teachers' "stories to live by" potentially becoming their "stories to leave by" (Craig, 2013, 2014).

The dynamism inherent in the transformation process is evident in both the content of PPK and its sources, which are intricately intertwined in an interactive manner. This study revealed distinct patterns of PPK transformation among different teachers. For instance, Ting's transformation predominantly pertains to classroom teaching activities, with an emphasis on aspects such as design, arrangement, and functionality. Qian's PPK transformation, however, is centered around the evolving cognition of innovative teaching ideals and the effectiveness of classroom teaching activities. In contrast, Yue's PPK transformation is more comprehensive, spanning teaching activities, content such as learning strategies, and pedagogical approaches. These variations in the content of transformed PPK are associated with their respective sources. This observation is consistent with the findings of Ferry et al. (2022), who reported that the experiences student teachers gain during their teacher education have the most profound impact on their PPK, particularly regarding instruction and interactions with students in school. Meanwhile, personal experiences before embarking on teacher education significantly influence their PPK about the classroom context and their roles as teachers. Similarly, Chaharbashloo et al. (2020) highlighted the dynamic alignment between different types of PPK and their sources.

6. Conclusion

This study embarked on an exploration of how preservice teachers acquire PCK within a blended learning community, the manner in which they transform PCK into their PPK, and the role of the community in shaping this transformation.

It was determined that all participants acquired PCK in relation to conceptual teaching ideals and lesson designs. However, differences were observed both in focus and acceptance of PCK, and in the degree and scope of transformation from PCK to PPK. The transformation and progression of PPK transpire through a selective and dynamic process, characterized by a prevailing filtering mechanism and accompanied by tension. The variance in transformation is influenced by the internal components of the blended learning community, such as prior middle school English learning experiences and course expectations, as well as external conditions, such as teaching evaluations. While the blended community shapes the PPK transformation, it concurrently establishes a dynamic complex system. In this system, the construction of collaborative resources based on peer interaction engenders opportunities for the collision and reflection of diverse understandings, thereby facilitating individual preservice teachers' PPK transformation and further development.

The findings of this investigation carry implications for teacher educators in designing and delivering methodology courses to augment student teachers' construction of PCK and PPK. As Rowan et al. (2021) emphasize, it is crucial to teach for diversity. The preservice teachers' previous school English learning experiences should be considered when designing learning activities and tasks, so these experiences can serve as bridges, enabling learners to connect theoretical knowledge acquired in the community with their prior

experiences. An orientation should be incorporated into the course design to elicit clear, specific, and forward-looking learning expectations from the preservice teachers, fostering more fruitful achievements. It is vital to provide appropriate guidance to avoid right-or-wrong binary judgement on theoretical knowledge when preservice teachers interact in the blended learning community, enabling them to discuss from multiple perspectives while maintaining the integrity and depth of the learning community. While offline and online activities and tasks can be integrated within a blended learning community, it may be advantageous to differentiate the focus of these activities to some extent, ensuring that both the immediate and delayed temporal features of the two modes are optimally leveraged.

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 humans were approved by School of Foreign Languages, Central China Normal University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

QX: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. TW: Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing.

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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 professional training impacts teaching innovation among ideological and political teachers: the mediating and moderating role of basic psychological needs satisfaction

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The aim of this study is to explore the impact of professional training on teaching innovation among senior high school ideological and political teachers. By introducing the concept of basic psychological needs satisfaction as a mediating factor, the study seeks to uncover the mechanisms and patterns that manifest in teaching innovation within the Chinese cultural context. To gather empirical data, a questionnaire survey was administered to a sample of 780 teachers in this specialized field. The results showed that providing more professional training is an effective way to enhance teaching innovation. Drawing on Self-Determination Theory, the satisfaction of basic psychological needs (competence, relatedness, and autonomy) was found to play an important role in this process. Competence need satisfaction and relatedness need satisfaction played a mediating role, while autonomy need satisfaction played a moderating role. Based on these findings, several recommendations are provided to support the professional training of senior high school ideological and political teachers and enhance their innovation, including providing personalized training programs, building a mentor system, and allowing greater autonomy in school management.

KEYWORDS

professional training, basic psychological needs, teaching innovation, ideological and political teachers, mediating effect, moderating effect

1. Introduction

Innovation is not a new phenomenon (Fagerberg, 2006). As societal progress and technological advancements continue to unfold, the imperative for innovation grows increasingly salient. For a corporation, innovation is considered to be the corner stone of the success and survival (Yesil and Sozbilir, 2013). In schools, innovation also plays a pivotal role. Creative atmosphere "will change a classroom from a four walled room filled with educational hopes into an environment that is infused with excitement, curiosity, and genuine student learning" (Simplicio, 2000). In the classroom, the teacher's innovative behavior and creative teaching strategies (Mahajan and Kaushal, 2017) can enhance students' creativity. A classroom environment imbued with a culture of innovation can significantly enhance students' academic engagement and interest (Khikmah, 2019), academic record will also improve

accordingly (Baghaei and Riasati, 2015). Since the onset of the COVID-19 pandemic in 2019, measures such as restrictions on movement and large gatherings have been implemented in order to mitigate the risk of infection. As a result, teachers and students have had to adapt and find new ways to continue teaching and learning remotely (Bozkurt et al., 2020). One such approach, known as blended learning, combines traditional face-to-face and online components. While such changes may bring about overall positive effects for teachers, they can also introduce complications as the specifics of the change process are often uncertain. To address this uncertainty and maintain teaching efficiency, teachers must seek out new approaches in their daily work.

In China, beginning in 2019, the government has successively issued a series of directives, such as "Opinions on Deepening the Reform and Innovation of Ideological and Political Theory Courses in Schools for the New Era" and "Implementation Plan for the Reform and Innovation of Ideological and Political Theory Courses in Schools for the New Era." These directives aim to orchestrate the integrated development of the "Integrated Ideological and Political Course in Schools and Universities" across primary, secondary, and tertiary education levels. Within this integrated framework, senior high school-level courses serve as a critical juncture, bridging the foundational and advanced aspects of this education model. In China, senior high school ideological and political courses are predicated on students' cognitive development and focus on enhancing their political literacy. These courses are comprehensive in scope, encompassing not only knowledge-based requirements but also extending to diverse dimensions such as values, ethics, and psychological well-being. The multifaceted nature of the content inherently demands higher levels of teaching innovation. Teaching approaches are increasingly shaped by the influence of internet and digital technologies (Henderson et al., 2017; Parong and Mayer, 2018). Regardless of whether this impact is positive (Lin et al., 2020) or negative (Falck et al., 2018), it sets forth new imperatives for teaching innovation in senior high school ideological and political courses. Furthermore, the unique developmental characteristics of senior high school students can impact the effectiveness of teaching and the innovation in instructional methods to a certain degree (Tong et al., 2003). Therefore, whether guided by policy directives or necessitated by objective developmental imperatives, teaching innovation in ideological and political courses is requisite to adapt to their evolving landscape.

Under such circumstances, educational institutions should offer effective training to teachers (Rasheed et al., 2020). According to previous studies, professional training might have an impact on teaching innovation, but its internal impact mechanism is not clear and needs to be further explored. Scholars have yet to engage in data-driven analyses or empirical investigations specifically targeting the factors that influence teaching innovation in ideological and political courses at the senior high school level in China. This study aimed to improve the teaching ability of Chinese senior high school ideological and political teachers by investigating how professional training impacts their teaching innovation. This focus affords a more comprehensive and objective view of current professional training and offers some individualized approaches for professional training from a psychological perspective. The study concurrently furnishes empirical data rooted in the Chinese context, as well as insights framed within the cultural milieu of the nation.

2. Literature review and development of hypotheses

2.1. Teaching innovation and influencing factors

In the realm of teachers' professional development, innovation competence is a cornerstone that covers multifarious facets of a teacher's responsibilities within the school environment. Teaching innovation is defined as the origination or adoption of novel and efficacious pedagogical practices, methodologies, or educational materials in the classroom setting (Anderson et al., 2014). Innovative teaching is fundamentally predicated upon fostering a culture of creative learning and stimulating proactive student engagement through the integration of emerging ideas, approaches, tools, and subject matter (Kahramonovna, 2021).

The concept of innovation is multifaceted, being perceived either as an outcome, a process, or even a mindset (Kahn, 2018). Some scholars posit that innovation is an amalgamation of ideas, practices, and eventual outcomes, encompassing stages such as problem perception, hypothesis formation and testing, modification, and ultimate resolution (Rerke et al., 2020). Typically, this iterative process is either executed by the educator or collaboratively with peers (Messmann et al., 2022).

To conduct a comprehensive study of teaching innovation, it is imperative to scrutinize the variables that influence it. Numerous studies have demonstrated that innovation is significantly affected by organizational factors such as leadership (Samsir, 2018; Villaluz and Hechanova, 2019), transformational leadership (Messmann et al., 2022), involvement climate (Naqshbandi et al., 2019), teacher training (Artacho et al., 2020), knowledge sharing (Kim and Shim, 2018), organizational learning (Putra et al., 2020), collaborative culture (Yang et al., 2018), and a plethora of institutional factors such as school culture, peer support, and resource availability (Davies et al., 2014; Cai and Tang, 2022).

In addition to organizational variables, personal factors of the educator also play a substantial role in shaping the readiness and creativity levels for introducing pedagogical innovations. These include the educator's motivation for success, value orientations, propensity for calculated risk-taking, and willingness to assume responsibility in relation to risks and creativity (Rerke et al., 2020). Individual capabilities such as domain-specific expertise, knowledge process (Imran et al., 2018), knowledge search (Wang et al., 2019), and intrinsic motivations for innovation (Rosenblatt, 2011) significantly affect the innovation landscape. A research study conducted on more than 1,770 PhD scientists and engineers at Cambridge University posits that although both formal and informal incentives must be considered, individual motives warrant particular attention (Sauermann and Cohen, 2010). Therefore, scrutinizing the impact of these individualized variables is essential for the advancement of teaching innovation. It is noteworthy that organizational factors ultimately exert their influence on teaching innovation by shaping individual teacher characteristics.

2.2. Professional training and innovation

In advancing the discourse on teachers' professional trajectory, a multi-dimensional approach to teacher training is indispensable.

Teacher training encompasses pre-service stages, such as formal education at the university level and practical internships (Fuentes-Abeledo et al., 2020), along with in-service professional development and experiential learning acquired through occupational practices. Interestingly, empirical evidence suggests no significant correlation between pre-service training or examination scores and teacher productivity (Harris and Sass, 2011).

Within the sphere of human resource management, professional training is conceptualized as "planned and systematic activities aimed at enhancing the acquisition of knowledge, skills, and attitudes" (Salas et al., 2012). Contrasted with general education, professional training holds a specific orientation toward skill application, aiming primarily to facilitate the transference of acquired knowledge into the workplace (Bonnes and Hochholdinger, 2020). Transposing this definition to the domain of teacher development, professional training for teachers is orchestrated learning activities designed to foster the elevation and refinement of pedagogical knowledge, competencies, and instructional quality, implemented either socially or institutionally. It can be bifurcated into hard-skill trainings, which include domain-specific knowledge, instructional methodologies, and cutting-edge instructional technologies like digital competence (Artacho et al., 2020), and soft-skill trainings, encompassing creativity, collaborative teaching, professional ethics, and pedagogical attitudes.

The relationship between professional training and innovation is close. From an organizational management standpoint, investment in human capital is crucial for enhancing an enterprise's innovative capacity (Mariz-Perez et al., 2012). Empirical studies within industrial sectors have demonstrated that well-trained employees act as direct catalysts for innovation (González et al., 2016).

For teachers, both hard and soft skill training are conducive to fostering teaching innovation. Research indicates that specialized competency training, such as digital literacy, plays an instrumental role in encouraging pedagogical innovation (Artacho et al., 2020). Enhancement in teaching abilities through professional development not only augments teachers' skill sets but also invigorates their creative potential (Harris and Sass, 2011). The advantages of such training encompass knowledge acquisition, the nurturing of collaboration, the cultivation of inventive thought, and the development of problem-solving abilities (Kottke, 1999)—all of which are vital components of teaching innovation. Therefore, we posit the following hypothesis:

> *Hypothesis 1 (H1)*: Teacher professional development positively impacts pedagogical innovation.

Further investigation is warranted to explore how specific hard and soft skills contribute to teacher-led innovation. Beyond training related directly to innovation skills, could other forms of professional training also stimulate creative teaching practices? As previously elucidated, motivation serves as a critical catalyst in the innovation equation. Consequently, it becomes imperative to delve into the underlying mechanisms by which teacher professional development influences innovation, particularly emphasizing the pivotal role of motivation.

2.3. Satisfaction of basic psychological needs

Self-Determination Theory (SDT) introduces three basic psychological needs: competence, relatedness, and autonomy (Deci et al., 2017). Competence relates to an individual's sense of control over their environment and the desire to acquire new skills. Relatedness concerns positive relationships and social support, while autonomy pertains to individual control over one's actions and perceptions of psychological freedom.

According to the SDT, motivation can be categorized into two types: intrinsic and extrinsic (Ryan and Deci, 2000). When examining the motivational factors influencing teacher innovation, extrinsic motivation can manifest both materially, such as monetary rewards, and immaterially, such as recognition (Rosenblatt, 2011). However, some studies suggest that extrinsic rewards may adversely affect the workplace environment by engendering competitive behaviors that stifle relationships, hinder openness and learning, discourage risk-taking, and ultimately undermine intrinsic work motivation (Ahmed, 1998). Conversely, a considerable body of research posits that many innovations are initially fueled by intrinsic motivations (Kumar and Namrata, 2022). For instance, the quest for intellectual challenges has been found to be strongly correlated with both the effort expended and the innovative performance achieved (Rosenblatt, 2011). Teachers often derive satisfaction from solving problems (Stephan, 1996) or experience intellectual excitement when seeing their ideas come to fruition (Davenport et al., 2003). Intrinsic motivation has been shown to have a direct positive impact on individual innovative behavior, whereas extrinsic motivation has an indirect positive impact mediated by intrinsic motivation (Xu et al., 2009). Thus, by studying the mechanisms to transform extrinsic motivation into intrinsic motivation, policies can be more effectively formulated to promote teacher innovation. Ryan and Deci's research corroborates that satisfying basic psychological needs facilitates this transformation (Ryan and Deci, 2000).

Professional training can enhance the sense of need satisfaction. Once intrinsic motivation is augmented, it can promote teaching innovation. Therefore, the role of the three basic psychological needs in promoting innovation should be considered in this study. Satisfaction of the three basic psychological needs, is typically used as a composite, but sometimes analyzed with each need separately. For example, one study found that transformational leaders could support the satisfaction of these needs in distinct ways (Messmann et al., 2022). Given the prior analysis that professional competence is a key determinant of teaching innovation and that professional training is a pivotal mechanism for skill enhancement which can meet the need of competence need. we formulate the following hypothesis:

> *Hypothesis 2 (H2)*: The satisfaction of the competence need (SOCN) mediates the relationship between teachers' professional training and teaching innovation.

For teachers, teaching innovation will become considerably challenging without ample discussion, collaboration, and peer support (Liu et al., 2022). Professional training aims to improve such collaborative abilities which can meet the need of relatedness need., leading to the next hypothesis:

> *Hypothesis 3 (H3)*: The satisfaction of the relatedness need (SORN) mediates the relationship between teachers' professional training and teaching innovation.

Previous studies have found that autonomy need satisfaction can have a significant moderating effect in certain situations. For example,

a study of 184 New Zealand employees found job autonomy has a significant interaction effect on the relationships between distributive justice and turnover intentions (Haar and Spell, 2009). Autonomy need satisfaction is primarily attributed to the decentralization of management. This factor operates independently of the training and innovation processes, yet it could potentially affect the strength of the relationship between professional training and innovation. In the cultural context of China, teachers may be particularly inclined to defer to authority (Zheng et al., 2021), which could potentially influence teaching innovation. Thus, the study proposes the final hypothesis:

> *Hypothesis 4 (H4)*: The satisfaction of the autonomy need (SOAN) moderates the relationship between teachers' professional training and teaching innovation.

3. Materials and methods

3.1. Sample and data collection procedures

In this study, the data were collected from senior high school ideological and political teachers in the S province of China. We distributed 900 questionnaires using the principle of random stratified sampling and received 825 responses, yielding a recovery rate of 91.6%. Out of these responses, 780 were found to be valid after removing questionnaires with excessive repetition or missing values (54 questionnaires removed), resulting in an effective rate of 94.5%. A descriptive analysis was performed on the sample by gender, age, teaching experience, professional title, and the type of school. The results are presented in Table 1.

3.2. Measures

In this study, three measurement tools were utilized: teachers' professional training scale, the satisfaction of basic psychological needs scale, and the teaching innovation scale. The satisfaction of basic psychological needs scale is comprised of three dimensions: competence need satisfaction scale, relatedness need satisfaction scale, and autonomy need satisfaction scale. These dimensions were measured separately and analyzed individually. All scales utilized a 5-point Likert scoring system, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire items were revised following a small-scale test and the reliability and validity of the revised questionnaire were tested. The validity of the measurement tools was assessed using confirmatory factor analysis.

3.2.1. Teachers' professional training scale

In the study, the professional training scale changes from the Extensive Training Scales (Sun et al., 2007), which contains 5 items (a sample item was, "Our institution is willing to invest substantial amounts of time and financial resources in the professional development of our teaching staff"). The internal consistency of the measure was determined using SPSS, resulting in an alpha coefficient of 0.929, indicating a high degree of internal consistency. Additionally, the construct reliability (CR) was calculated to be 0.9318 and the

TABLE 1 Demographics statistics.

Variable	Categories	Number of samples	Proportion
Gender	Male	296	37.9%
	Female	484	62.1%
Age	25 and under	44	5.6%
	26–35	218	27.9%
	36–45	340	43.6%
	46—50	106	13.6%
	51 and above	72	9.2%
Teaching experience	Less than 3 years	100	12.8%
	3–5 years (inclusive)	75	9.6%
	5–10 years (inclusive)	86	11.0%
	10 or more years	519	66.5%
Title	Top tier	3	0.4%
	Senior	139	17.8%
	Intermediate (or Level 1)	339	43.5%
	Junior (or Levels 2 and 3)	257	32.9%
	Unclassified	42	5.4%
School type	Public	675	87%
	Private	105	14%

average variance extracted (AVE) was determined to be 0.7335, providing further evidence of the measure's reliability.

3.2.2. Satisfaction of basic psychological needs scale

The basic psychological needs satisfaction scale comes from the research results of Deci et al. (2001). It consists of three subscales:

The SOCN contains six items (Cronbach's $\alpha = 0.773$; a sample item was, "I frequently have the opportunity to acquire new skills that I am interested in during my work.").

The SORN contains eight items (Cronbach's $\alpha = 0.878$; a sample item was, "I have a good relationship with my colleagues.")

The SORN contains seven items (Cronbach's $\alpha = 0.781$; a sample item was, "I have the flexibility to decide on my operation way of working according to my preferences.")

3.2.3. Teaching innovation scale

The scale of teachers' teaching innovation in this study comes from an empirical study of teachers' professional learning (Liu et al., 2016), with a total of 5 items.

The first two items measure teachers' innovative thinking (sample item, "In my teaching practice, I prefer to adopt a creative approach by applying various teaching techniques, methodologies, or teaching philosophies that promote the engagement of students' cognitive processes.").

The third is the communication of innovative thinking with colleagues ("I enjoy engaging in communication and sharing my new ideas with colleagues, in order to gain support and recognition.").

The last two items measure the competence to implement innovation (sample item, "In order to realize my new ideas in teaching, I will strive to acquire the necessary resources."). The five items

comprehensively represent teachers' teaching innovation. The calculated alpha value was 0.935 with good reliability. The CR value was 0.9318, AVE 0.75, and the validity was acceptable.

3.3. Data analysis

Before carrying out hypothesis testing, the discriminant validity among the multi-item constructs and common method variance were assessed to ensure the validity of the measurement model. Pearson's correlation analyses were carried out to lay a foundation for hypothesis testing. The hypotheses were tested using structural equation modeling. The analytic strategy proceeded in three stages. (1) The main descriptive statistics, correlation matrix, differences, and stratified regression analysis were computed using SPSS. (2) Structural equation modeling (SEM) was used to explore the mediating effects using the software AMOS. SEM was selected for this study because it allows for the examination of complex relationships among variables in a more comprehensive manner. (3) The moderated effect was tested using the PROCESS macro for SPSS (Hayes, 2017). All SEM-based tests in this study were conducted through a bootstrapping procedure with a bootstrap sample of 5,000.

4. Result

4.1. Descriptive statistics and correlation matrix

The descriptive statistics and correlation matrix of each main variable are presented in Table 2.

As demonstrated in Table 2, the average values of all research variables are largely between 3.5 and 4.4, indicating that the basic needs of the sample teachers are largely satisfied. Among these, relatedness need satisfaction ($M = 4.357$, SD = 0.584) and competence need satisfaction ($M = 4.112$, SD = 0.621) are particularly well-satisfied. However, the degree of satisfaction with regard to autonomy need satisfaction ($M = 3.563$, SD = 0.707) was slightly lower. Teachers' perception of professional training ($M = 4.234$, SD = 0.834) was high, as was their level of teaching innovation ($M = 4.399$, SD = 0.643). The correlation between all the research variables reached the significance level of 0.01 and above, indicating a significant positive correlation. Analysis of the correlation matrix reveals that the correlations between variables are consistent with theoretical expectations and that the mutual prediction relationships between variables can be further explored and discussed in the context of the model.

4.2. Analysis of differences among groups

The results of a one-way analysis of variance showed a positive correlation between teaching experience and teaching innovation. Specifically, the data indicated that teachers with more than 10 years of experience had significantly higher levels of teaching innovation compared to those with less than 3 years and 3–5 years of experience.

In China, public schools are established and run by the government, while private schools are established and run by non-governmental organizations such as enterprises. The results of the comparison between professional training and teaching innovation among public and private senior high school teachers showed that teachers in public schools had significantly higher levels of both teaching innovation ($M = 4.431$ for public vs. $M = 4.191$ for private) and professional training ($M = 4.269$ for public vs. $M = 4.008$ for private) compared to those in private schools.

4.3. Stratified regression analysis

A hierarchical regression analysis was conducted to examine the ability of professional training and psychological needs to predict teaching innovation. The tolerance of all factors was found to be above 0.5, and the variance inflation factor (VIF) was less than 2, indicating the absence of serious collinearity issues among the factors. Control variables, including gender, teaching experience, and school type, were included in the regression model. The goodness-of-fit R-squared of the control variables and teaching innovation was 0.024, indicating that they explained a small portion of the variance. However, the overall F value of the multiple regression test was 7.368, reaching statistical significance at the 0.001 level. These results suggest that there is a significant positive relationship between teaching experience and teaching innovation (Table 3).

Next, professional training was added to the regression model. The goodness-of-fit R-squared for model 2, which included the autonomy variables, was 0.281, indicating that it explained 28.1% of the variance in teaching innovation. The F value for significant change was 77.03, reaching statistical significance at the 0.001 level, indicating a good overall fit of the equation. The standard coefficient β for professional training was 0.51, which was statistically significant at the 0.001 level. These results demonstrate that professional training has a significant positive effect on teaching innovation.

Finally, the three dimensions of basic psychological needs were added to the regression model. The goodness-of-fit R-squared for model 3, including the autonomy variables, was 0.518, an increase of 23.7% compared to model 2. The F-value for significance change was 120.449, reaching statistical significance at the 0.001 level. The

TABLE 2 Variable description statistics and correlation matrix.

	Mean	Standard deviation	1	2	3	4
1. Autonomy need satisfaction	3.563	0.707	1			
2. Competence need satisfaction	4.112	0.621	0.589**	1		
3. Relatedness need satisfaction	4.357	0.584	0.505**	0.752**	1	
4. Professional training	4.234	0.834	0.465**	0.447**	0.454**	1
5. Teaching innovation	4.399	0.643	0.474**	0.661**	0.610**	0.518**

TABLE 3 Stratified regression analysis results.

Variable		Dependent variable		
		Model 1	Model 2	Model 3
Control variables	Gender	−0.018	−0.034	−0.033
	Teaching experience	0.111**	0.1**	0.076**
	School type	−0.086*	−0.036	0.001
Independent variable	Professional training		0.51***	0.237***
Intermediate variable	Autonomy need satisfaction			0.058
	Competence need satisfaction			0.361***
	Relatedness need satisfaction			0.199***
Regression model summary	R^2	0.024	0.281	0.518
	F	7.368***	77.03***	120.449***

*Indicates significance at the 0.05 level.
**Indicates significance at the 0.01 level.
***Indicates significance at the 0.001 level.

standard coefficient β shows that the SOCN and relatedness need has a significant positive effect on teaching innovation. However, the SOAN did not reach statistical significance, with the lowest coefficient of 0.058. It can also be found that the regression coefficient of professional training is reduced to 0.237 after adding the variable of psychological needs, which is still significant. Further tests for the mediating and moderating effects can be conducted.

4.4. The mediating effect of competence need satisfaction

The structural equation model is a statistical tool used to evaluate relationships between variables. In this study, it was used to investigate the relationship between competence need satisfaction, professional training, and teaching innovation. The results of the model are depicted in Figure 1.

The fit of the mediating model of competence need satisfaction was analyzed. The key fit indices X^2/df = 2.852, GFI = 0.91, TLI = 0.934, CFI = 0.944, RMSEA = 0.08. The results indicate that the GFI, TLI, and CFI values in the above indices are all greater than 0.9, the chi-square to degrees of freedom ratio is under 3, and the RMSEA value is equal to 0.08, indicating a good fit.

The Bootstrap method was employed to estimate the mediation model using Amos software. The results of the data analysis show that all path coefficients are significant, indicating that competence need satisfaction acts as a substantial mediating factor in the relationship between professional training and teaching innovation.

The total effect of professional training on teaching innovation is the sum of all the path coefficients, while the product of the path coefficients from professional training to competence need satisfaction and then to teaching innovation is the mediating effect. The calculation of the mediation and total effects was performed based on the obtained path coefficients as follows: the indirect effect was calculated to be 0.383 (0.535 * 0.715), and the total effect was calculated to be 0.543 (0.16 + 0.383). The proportion of the indirect effect to the total effect was 70.53%, which exceeds the direct effect of professional training. The results indicate a strong mediating effect of competence

need satisfaction on the relationship between professional training and teaching innovation.

4.5. The mediating effect of relatedness need satisfaction

To further examine the relationship between relatedness need satisfaction, professional training, and teaching innovation, a structural equation model was constructed and tested using Amos software. The results of the model are depicted in Figure 2.

The fit of the mediating model of relatedness need satisfaction was analyzed. The key fit indices X^2/df = 2.915, GFI = 0.941, TLI = 0.928, CFI = 0.938, RMSEA = 0.08. The results indicate that the GFI, TLI, and CFI values in the above indices are all greater than 0.9, the RMSEA value is equal to 0.08, and the chi-square to degrees of freedom ratio is under 3, indicating a good fit.

The Bootstrap method was employed to estimate the mediation model using Amos software. The data reveals that each path coefficient is significant, indicating that relatedness need satisfaction acts as a substantial mediating factor in the relationship between professional training and teaching innovation.

The calculation of the mediation and total effects was performed based on the obtained path coefficients as follows: the indirect effect was calculated to be 0.279 (0.535*0.715), and the total effect was calculated to be 0.544 (0.265 + 0.279). The proportion of the indirect effect to the total effect was 51.29%, which slightly exceeds the direct effect of professional training. The results indicate a significant mediating effect of relatedness need satisfaction on the relationship between professional training and teaching innovation.

4.6. Moderating effect of autonomy need satisfaction

The moderating effect of autonomy need satisfaction on the relationship between professional training and teaching innovation was analyzed using Model 1 in Process (Hayes, 2017), a plug-in of SPSS. To prevent collinearity between interaction terms and other
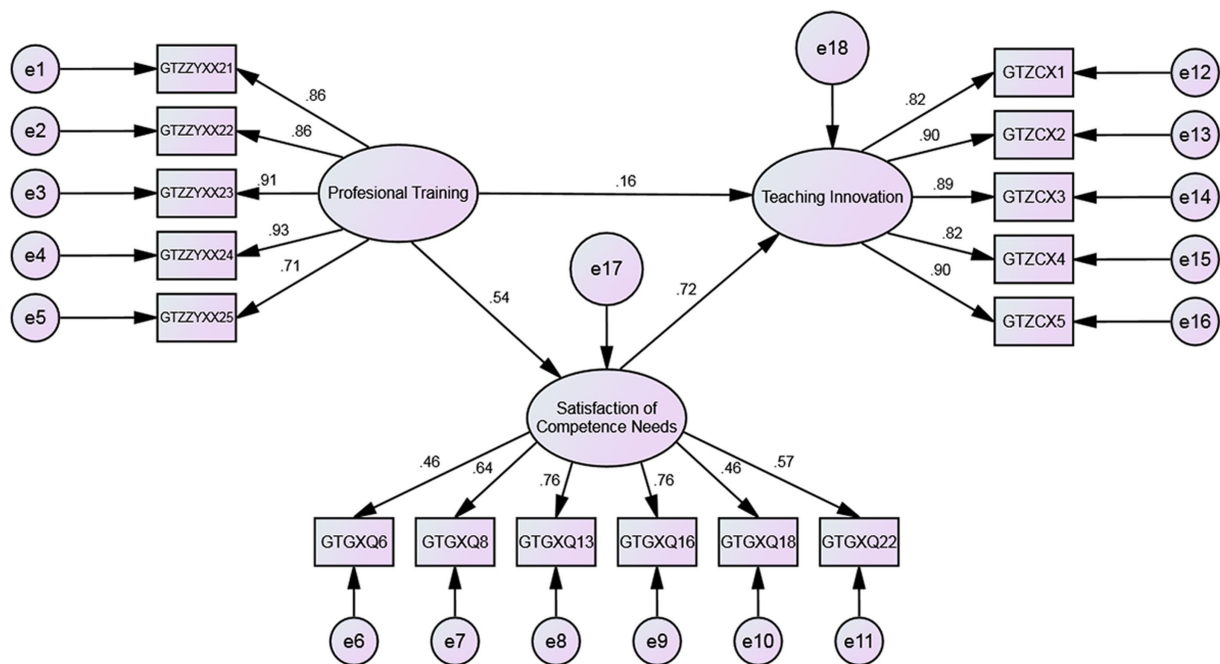
FIGURE 1
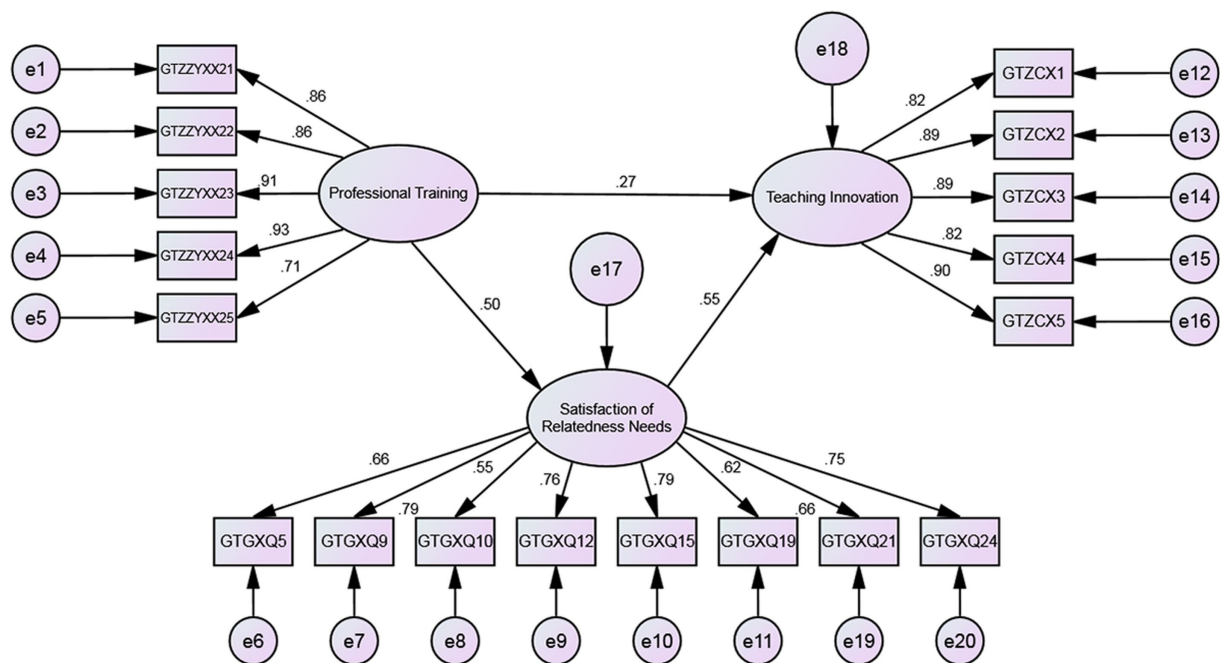Mediating effects of competence need satisfaction in structural equation model.

FIGURE 2
Mediating effects of relatedness need satisfaction in structural equation model.

factors, it is necessary to decentralize the professional training variable and the autonomy need satisfaction variable.

The adjusted R squared value is 0.354, indicating that this model explains 35.4% of the variance in teaching innovation, which is significant at the 0.001 level. The regression model of teaching innovation reveals that the *p* value of the interaction term between

professional training and autonomy need satisfaction is significant at a level lower than 0.001, indicating a significant moderating effect. The R-square value of the interaction term is 0.0163, indicating an increase in the model's explanatory power for variance in teaching innovation by 1.63%. When autonomy need satisfaction is high $(M+1SD=0.7065)$, the simple slope is 0.4251 and is significant.

Similarly, when autonomy need satisfaction is low ($M - 1SD = -0.7065$), the simple slope is 0.2473 and is also significant. This demonstrates that professional training has a greater positive impact on teaching innovation when teachers feel high autonomy need satisfaction. However, when autonomy need satisfaction is low to a certain extent (less than 1.7853), the impact becomes insignificant. These findings suggest that autonomy need satisfaction plays a notable moderating role in the relationship between professional training and teaching innovation.

5. Discussion

The results of this study suggest that teachers with more years of experience tend to have higher levels of teaching innovation compared to those with less experience. However, prior research has yielded conflicting conclusions on this topic, with some studies indicating a negative relationship between teaching experience and innovation (Ghaith and Yaghi, 1997). The discrepancy in conclusions may be due to differences in the innovation environment of different organizations. In schools with a positive innovation atmosphere, experienced teachers tend to have a wealth of innovative thinking, leading to higher levels of innovation. In contrast, in schools with a negative innovation atmosphere, experienced teachers may have a lower level of innovation due to a lack of enthusiasm for new ideas. This study emphasizes the significance of exploring the underlying reasons behind the impact of professional training on teaching innovation, as superficial factors may not reveal the underlying mechanisms.

The data indicate a significant positive relationship between professional training and teaching innovation. Hypothesis 1 is verified. This finding is consistent with previous research in related fields, such as a study of 5,200 Norwegian enterprises which found a positive relationship between enterprises' use of employee training and their innovation activities (Børing, 2017), a Canadian workplace and employee survey which found that more training leads to more product and process innovation (Dostie, 2018). Another study of a Canadian energy company found that training for creativity and innovation can develop individual creative skills for exploration (Rampa and Agogué, 2021). This conclusion has important implications for teachers' professional development programs, as it highlights the role of professional training in promoting innovative teaching practices.

The data also indicate that the SOCN mediates the relationship between professional training and teaching innovation among senior high school ideological and political teachers. Hypothesis 2 is verified. Firstly, for teachers, professional training can provide the professional knowledge, teaching methods, and information technology required for teaching. The increase of knowledge can satisfy the competence need. This finding aligns with previous research on employees, which found that training is an important factor in the knowledge absorption process and can satisfy the competence need (Neirotti and Paolucci, 2013). Secondly, training has also been shown to encourage openness to new ideas, which can be a source of technological and organizational innovations (Neirotti and Paolucci, 2013). Research has shown that satisfying teachers' competence need can increase their confidence levels, which in turn has a positive correlation with entrepreneurial activity (Ebert et al., 2019). The acquisition of training knowledge involves the external internalization of knowledge. However, when the

training content is more targeted to meet teachers' competence need, this external internalization process transforms into integration. This internal drive motivates teachers to apply knowledge more creatively during the teaching process.

Moreover, the data shows that the SORN mediates the relationship between professional training and teaching innovation. Hypothesis 3 is verified. Professional training has the potential to enhance teachers' satisfaction of their relatedness need, then increase their teaching innovation. The investments made in training and development by organizations create an environment allowing for the exchange of knowledge and ideas among employees (Lau and Ngo, 2004). For teachers as well, participation in professional training can also create a positive communication atmosphere. Such communication can increase teachers' sense of relatedness, as they build trust and engage in more communication and sharing. When teachers feel a high level of trust in their colleague relationships, they are more likely to engage in collaboration. Studies in the manufacturing industry have shown that the higher the knowledge sharing, the higher the innovation behavior of members (Hyoseop and Hongin, 2020). When teachers' relatedness need is satisfied, they are more likely to engage in collaboration and communication with their peers, which can foster the sharing and refinement of ideas and ultimately generate more innovative ideas. Additionally, teachers are more inclined to proactively seek additional resources and support from colleagues to implement innovative teaching practices, thereby facilitating the adoption of innovative behaviors. By providing professional training for teachers, schools can create a more positive and supportive environment, promoting not only teachers' professional growth but also their teaching innovation.

Finally, the results support Hypothesis 4, as the SOAN moderates the relationship between professional training and teaching innovation. One possible explanation is that when the need for autonomy is satisfied, people feel more interested, engaged, and happy (Niemiec and Ryan, 2013). When teachers experience greater autonomy, they are more likely to engage in active and open-minded thinking during the training process, which may lead to the generation of more innovative ideas. So that satisfying the autonomy need of teachers could lead to a higher impact of professional training on teaching innovation. This study is also in line with previous research indicating that job autonomy has a significant effect on innovation behavior (Hyoseop and Hongin, 2020) and that granting individuals and teams more freedom promotes innovation (Lumpkin and Dess, 1996). However, top-down management pressure reduces teachers' sense of autonomy and hinders teaching innovation (Cai and Tang, 2022). The data shows that the mean value for autonomy need satisfaction (3.563) was lower than the levels of competence need satisfaction (4.112) and relatedness need satisfaction (4.357) surveyed in China. These findings suggest that teachers in China have a significant need for autonomy that is not being adequately satisfied. Based on this, it can be inferred that a higher need for autonomy satisfaction among the sampled teachers would lead to a more pronounced moderating effect. Therefore, granting teachers more autonomy is beneficial.

6. Practical implications and limitations

Emphasize the importance of senior high school ideological and political teachers' professional training and create a mentor system

(Hobson et al., 2009) where experienced teachers guide beginning teachers. This will help beginning teachers improve their skills quickly, handle basic tasks easily, and focus on teaching innovation. The mentor system can benefit both experienced and beginning teachers by combining the beginning teachers' innovative ideas with the experienced teachers' knowledge and experience, leading to an overall increase in innovation.

Schools should create personalized training programs for teachers at different career stages, taking into account their competence and relatedness needs. To meet competence need, professional training should align with teachers' personal development goals. To meet relatedness need, schools should encourage teachers to participate in professional training together. Grant teachers' greater autonomy need satisfaction in school management to boost their motivation and encourage innovation. By giving teachers more control over the professional training process and allowing them to experiment with new methods, schools can create an open, inclusive, and innovative environment that promotes teachers' professional development. It is suggested that schools should allocate resources and offer support to facilitate teachers' SOAN and encourage the exploration of innovative teaching approaches.

This study also has limitations. The S Province selected for this survey is a region with moderate economic development that offers a conducive economic and external exchange environment. The overall level of school-provided professional training for teachers in this region is higher than the national average. However, the conclusion from this study may not be effective in a region with a lower economy. In the future, it may be advisable to expand the sampling scope and analyze differences, such as differences in economic development, geographic location, and other factors.

It is also worth considering whether the findings of this study, which focused on senior high school ideological and political teachers, can be generalized to teachers at the primary and secondary education levels, or even to university teachers. Further research could examine the applicability of these conclusions to other contexts.

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 the Ethics Committee of China University of Petroleum. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication. CC led the study design and manuscript writing. YY conducted the data collection, analysis, and interpretation. All authors contributed to manuscript revision, read, and approved the submitted version.

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 landscape of flipped classroom research: a bibliometrics analysis

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Objective: The purpose of this study was to conduct a comprehensive review of existing research related to the flipped classroom and analyze it using bibliometrics.

Methods: The search strategy of Topic = ("flipped classroom" or "invert classroom") was used to construct a representative dataset of flipped classrooms in the Web of Science Core Collection (Science Citation Index Expanded) database up to November 2022. Author and country collaboration networks, hotspot distribution clustering, and historical citation networks associated with flipped classrooms were visualized by VOSviewer (Version 1.6.18) and *R*-Studio (Version 1.4).

Results: A total of 937 literature (868 articles and 69 reviews) were eventually included. The number of flipped classroom studies has increased dramatically since 2012. Europe, North America, China, and Australia have more research on flipped classrooms and have significant collaborations with other countries. Since flipped classrooms involve different subject areas and collaboration among authors is relatively fragmented. Numerous flipped classroom studies have been published in high-impact journals. The thematic trend suggests that the pros and cons of flipped classrooms and their application in medical education are possible research directions for some time to come.

Conclusion: Although the flipped classroom has a relatively short history, it has received a lot of attention and is currently enjoying a high level of overall acceptance. The flipped classroom has been further practiced in medical education, and we look forward to seeing its application in more subject areas (e.g., linguistics, mathematics, and computer science).

KEYWORDS

flipped classroom, bibliometrics analysis, education, review, VOSviewer

Introduction

Since the 21st century, information technology has been widely used in pedagogy (Rodríguez-Abad et al., 2022; Tsai et al., 2023). The flipped classroom has emerged as an overturning of the traditional teaching model, defined as a realignment of time in and out of the classroom, shifting learning decisions from the teacher to the student (McLaughlin et al., 2014). The proposed flipped classroom indicates that education is transforming from a

teacher-centered to a student-centered teaching strategy (Persky and McLaughlin, 2017). This novel approach, i.e., flipped classroom, is an instructional approach where traditional teaching methods are reversed. Students learn new content outside class, typically through video lectures or other pre-recorded materials, and then use class time for interactive, collaborative, and applied learning activities (Rotellar and Cain, 2016). As flipped classrooms have progressed, innovative implementation methods have emerged, such as personalized learning pathways (Narang et al., 2018), peer collaboration, social learning (Xiao et al., 2018), and integration of technology (Jong, 2023), which have increased effectiveness of flipped classrooms and met a various educational need.

With the COVID-19 outbreak in 2020, the idea of "classes suspended but learning continues" is rapidly driving the development of flipped classrooms in the context of various regional containment (Durfee et al., 2020; Wang et al., 2021; Feng et al., 2022). Consequently, the flipped classroom is gaining momentum, and educators from different countries continue contributing to its development and impact (Sun et al., 2022). A randomized controlled trial conducted by American scholars (Paul et al., 2023) showed that the flipped classroom significantly improves the clinical skills of medical students compared to online-only learning. A study from China (Lu et al., 2023) suggests that flipped classrooms improve students' course learning and promote higher-order ability-set acquisition; the researchers concluded that flipped classrooms allow a rationalized formative evaluation system. Wang (2017) summarized several lessons to promote flipped classrooms, including enhancing teachers' understanding of the merits of flipped classroom approach, establishing peer mentoring mechanisms, and effective teacher capacity building.

Several recent studies have evaluated the pros and cons of flipped classrooms relative to traditional teaching. Among them, Özbay and Çınar (2021), Youhasan et al. (2021), and Barranquero-Herbosa et al. (2022), conducted a systematic review of studies occurring in the nursing discipline from different perspectives on the impact of flipped classrooms on nursing education, explains that flipped classrooms can produce positive educational outcomes and improve the quality of teaching, but that more research that meets methodological quality standards is needed to consolidate the evidence. Betihavas et al. (2016) argued that students are actively engaged when teachers introduce and rationalize the purpose of flipped classroom models to them and that continuous assessment and improvement of flipped classrooms should be reinforced. Ødegaard et al. (2021) and Xu et al. (2019) used meta-analysis to report the advantages of flipped classrooms over traditional teaching regarding knowledge acquisition and skill competence. Nevertheless, A study by Al-Said et al. (2023) reflects the potential disadvantages of flipped classrooms, which include the inability to independently study the material, a large amount of material, and technical problems.

Nevertheless, most of the studies have reviewed the literature on flipped classrooms qualitatively (Chen et al., 2021; Barranquero-Herbosa et al., 2022; Naing et al., 2023) and lack an objective description of the status of flipped classrooms research. To elucidate the situation of flipped classrooms as a new educational model in different disciplines, it is necessary to understand better the overall landscape of flipped classroom-related research and future trends (e.g., applied disciplines, applicable population). Therefore, we conducted a comprehensive bibliometric analysis of the flipped classroom-related literature, describing the applications in different disciplines, country/author collaborations, classic citations, and thematic trends.

Methods

Data sources

Bibliometric data were collected using the Web of Science Core Collection (Science Citation Index Expanded) database. The database encompasses more than 20,000 peer-reviewed, high-quality scholarly journals, including open-access journals published in more than 250 medical, social science, and humanities disciplines worldwide, and is widely used for bibliometric analysis. In addition, the database provides the authors, countries, and keywords for each publication, which was necessary for this study.

We used topic-related searches to maximize the location of content relevant to our research topic. The search strategy included Topic = ("flipped classroom" or "inverted classroom"). The time horizon was limited to 2012–2022 for obtaining a recent literature overview.

Eligibility criteria

Our study had no restrictions on study population, design, or language. When non-English publications were encountered, we used DeepL for translation. Since the peer review process facilitates reliable scientific communication, stimulates meaningful research questions, and ensures accurate conclusions, we restricted the publication type of the search results to articles and reviews. In addition, by browsing titles and abstracts, we excluded articles irrelevant to flipped classroom topics.

Data analysis

All downloaded documents were imported to the VOSviewer (version 1.6.15), *R* (version 4.2.0), and Microsoft Excel 2019.

VOSviewer (Leiden University, Leiden, Netherlands) is a scientific knowledge-mapping software tool that uses web data to construct and visually analyze relationships and map scientific knowledge, showing structure, evolution, and collaborative relationships (van Eck and Waltman, 2010). Screened flipped classroom-related studies were imported into the VOSviewer software, and their authors and popular keywords were collected and organized. After synonymization and threshold settings were implemented, collaborative relationships between high-frequency keywords and highly productive authors were mapped, and a network cluster graph was formed. The cluster graph consists of network nodes and the connecting lines between them. The nodes represent the elements being analyzed, such as authors and keywords; their sizes represent the frequency of node occurrences; the lines between the nodes represent co-occurrence or related collaborations of the nodes, and the colors represent the different clustering relationships.

Bibliometrix, an *R* package for *R* software, allows a statistical analysis of indexes of relevant scientific literature and the study and

visualization of co-citation, coupling, and co-word analysis by constructing data matrices (Aria and Cuccurullo, 2017). After importing the content of flipped classroom-related studies into the Bibliometrix package in Plain text file format, the interactive menu presents the national publication numbers, historical citation relationships, and annual hot trends of flipped classroom-related studies.

Results

Trends in global publication

A total of 937 literature (868 articles and 69 reviews) related to flipped classrooms were retrieved. The earliest record of flipped classroom research in the Web of Science Core Collection database was in 2012, with three literatures reported. The number of articles published in this field has increased over the past ten years. In particular, the average annual number of articles published in the field was close to 50 in 2015 ($n = 43$) and 100 in 2018, reaching a peak of 186 in 2021. The time curve constructed by the logistic regression model suggested that the field is currently in a phase of steady growth in global publication output (Figure 1).

Web of science research area

The Web of Science research areas assigned by Clarivate Analytics is used to classify research papers. Each paper can be organized into at least one Web of Science database research area. In this study, the number of research areas covered by the flipped classroom literature increased from 4 in 2012 to 44 in 2021 (Figure 2A). The top ten most productive research areas are chemistry, computer science, dentistry oral surgery & medicine, education & educational research, engineering, environmental sciences & ecology, health care sciences & services, nursing, telecommunications, and science &

technology-other topics, representing 720 out of 868 publications, or approximately 78.9% of the total, Figure 2B illustrates the annual evolution of the ten areas with the most flipped classroom research results. Standing out in Figure 2B is education & educational research, reflecting the increasing research on teaching and learning in the flipped classroom over time, suggesting that this new teaching model has become the development direction of international teaching and has gradually been recognized by education researchers.

Distribution of countries/regions

The results show that flipped classroom studies have been conducted in 73 countries. The top five countries with the highest number of scientific results are the United States (363), China (207), Spain (80), Germany (44), and Australia (42). The United States was the first to publish flipped classroom research results, and since 2021, the number of Chinese publications has proliferated, surpassing that of the United States (Figure 3A). In addition to the number of scientific results, a country's research strength can be measured by national collaborations. Figure 3B depicts global partnerships, with the United States having the most national links, followed by China, Australia, the United Kingdom, and Canada. Other countries have fewer collaborations in flipped classroom research, with fewer than 15 connections.

Most influential authors

The *h*-index is based on the number of times a particular scientist's paper is cited and is a widely accepted measure of scientific performance. The top-ten authors of *h*-index are shown in Table 1. Mclaughlin JE is the most influential researcher and the earliest recorded author of flipped classroom research in the Web of Science database. We note that the high-impact ten authors are primarily from the United States, Spain, and China, indicating that education scholars
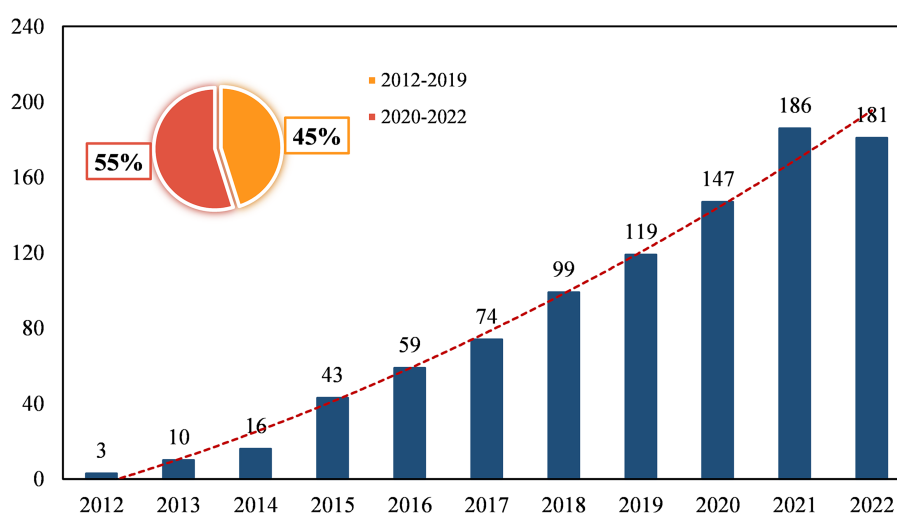

FIGURE 1
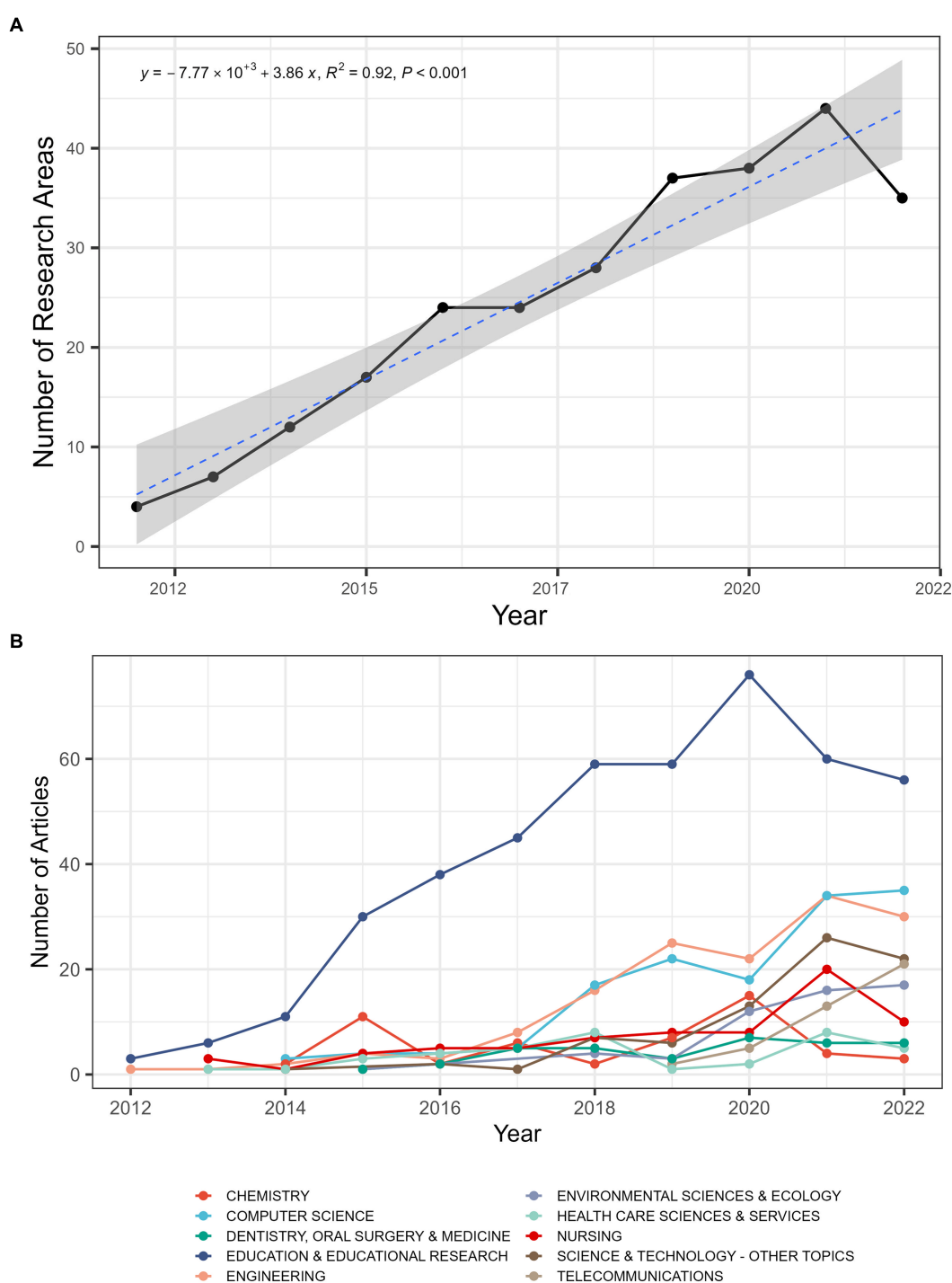Global trends in publications on flipped classrooms research.

FIGURE 2
(A) Number of Web of Science research areas covered in flipped classrooms-related literature. (B) Temporal evolution of the top-ten most productive Web of Science research areas in flipped classrooms-related literature.

from these three countries are leading in flipped classroom research. Cluster collaboration analysis was conducted using VOSviewer for authors of three or more articles, and 56 authors were grouped into 20 clusters (Supplementary Figure S1). The collaborative network mapping among authors showed a "blossoming" pattern, which indicates that flipped classroom research is being adopted and applied in multiple disciplines.

Most influential source journals

Flipped classroom research has appeared in 258 journals, with the top five publishing 220 papers (23.5%), while 158 journals (61.2%) have published only one paper on the flipped classroom. Twenty-two journals (8.5%) published more than ten papers. As shown in Figure 4, the top five journals in terms of several published articles were *BMC*
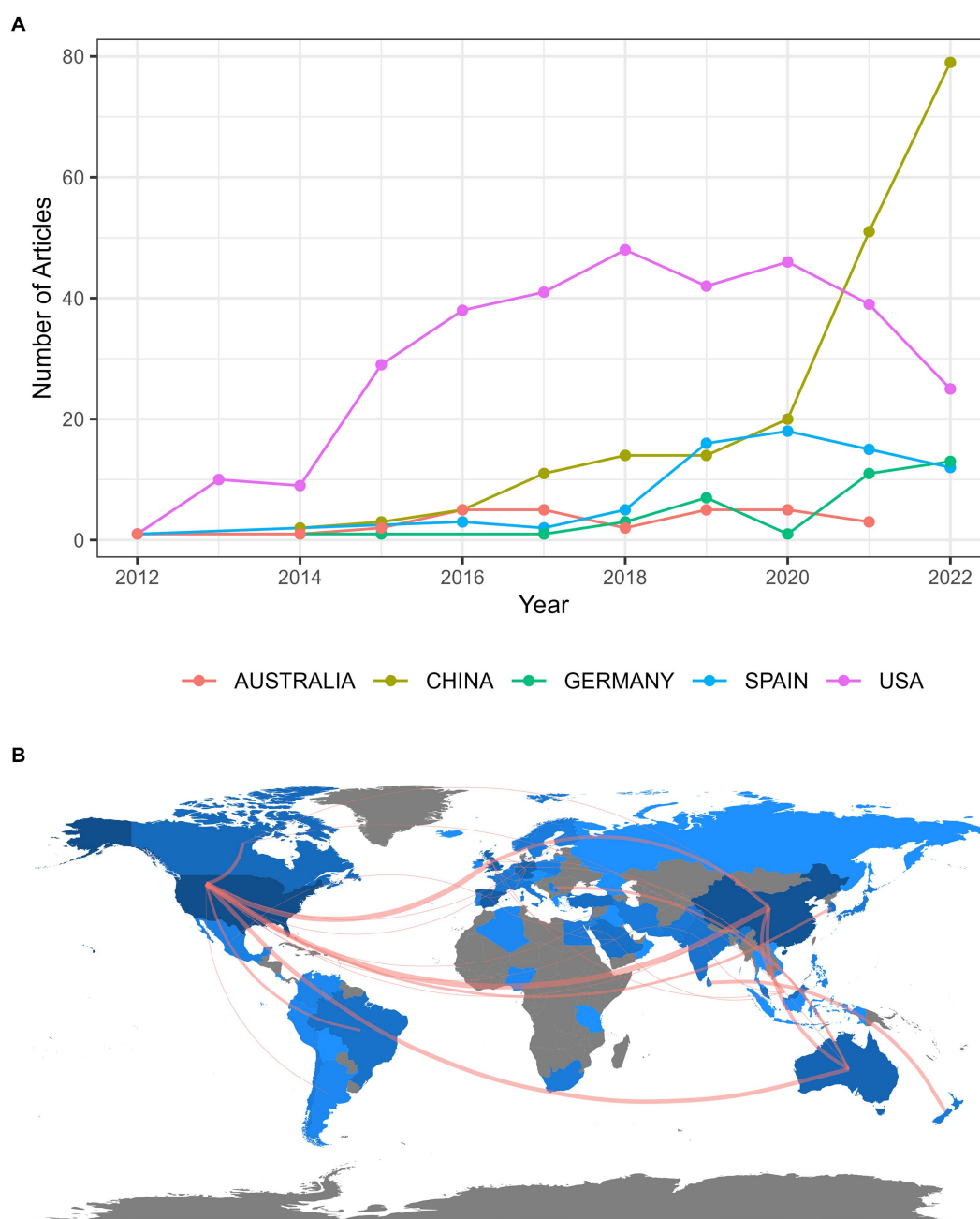
FIGURE 3
(A) Top five countries according to annual scientific production. **(B)** Map showing research collaboration between countries.

Medical Education (62), *Journal of Chemical Education* (48), *Sustainability* (42), *Computers & Education* (39), and *American Journal of Pharmaceutical Education* (29). Of these, *BMC Medical Education* and *Sustainability* had higher growth rates in the number of annual publications, while *Computers & Education* had the highest number of total local citations (Table 2).

The source journals for flipped classrooms research papers were highly dispersed according to Bradford's law (Supplementary Figure S2); the top ten most influential journals were selected based on the number of local citations (Table 2). According to Bradford's law, the journals marked with an asterisk are the core source journals in flipped classroom research, including *Computers & Education*, *Journal of Chemical Education*, *American Journal of Pharmaceutical Education*,

BMC Medical Education, and *Advances in Physiology Education*. Thus, these journals played a vital role in flipped classroom research during the study period.

Study of hotspots and co-occurring keyword clustering network analysis

We generated word clouds through the hotspot analysis function of the biblimetrix package that can reveal the most famous content in the field (Supplementary Figure S3). Active learning, blended learning, and medical education have become the most popular topics in the flipped classroom series of studies.

TABLE 1 The distribution of the top-ten authors with institutions and countries.

| Rank	Author	h-index	Country	Institutions
1	Mclaughlin JE	7	United States	University of North Carolina
2	Gonzalez-Gomez D	4	Spain	University of Extremadura
3	Gopalan C	4	United States	Southern Illinois University Edwardsville
4	Hew KF	4	China	The University of Hong Kong
5	Jeong JS	4	Spain	University of Extremadura
6	Khanova J	4	United States	University of North Carolina
7	Roth MT	4	United States	University of North Carolina
8	Wu CC	4	China	Taipei Medical University Hospital
9	Beckman TJ	3	United States	Mayo Clinic College of Medicine
10	Canada-Canada F	3	Spain	University of Extremadura

FIGURE 4
Temporal analysis of the publication source of flipped classrooms-related research.
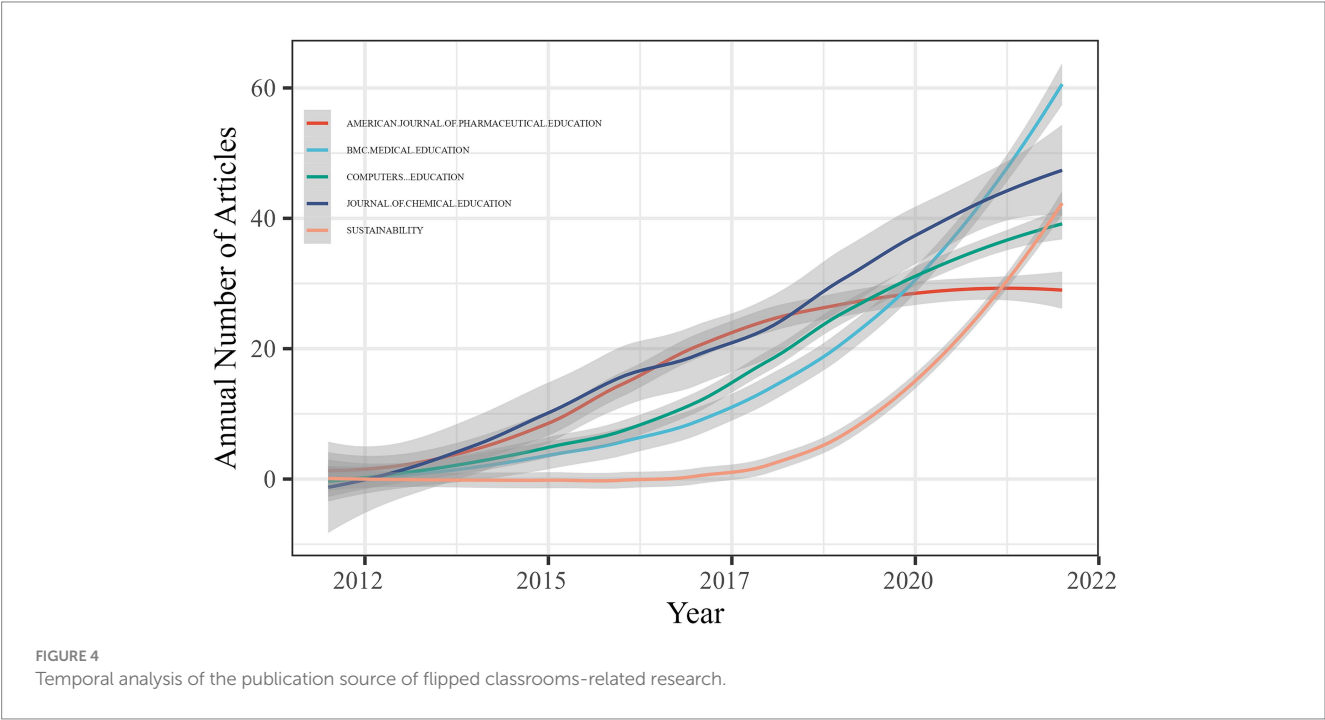
TABLE 2 The top-ten journals in flipped classrooms-related field.

Sources	Citation	n (%)	Impact factor	h-index
Computers & Education*	958	39	11.182	28
Journal of Chemical Education*	694	48	3.208	17
Academic Medicine	660	4	7.840	3
American Journal of Pharmaceutical Education*	598	29	2.876	18
BMC Medical Education*	586	62	3.263	14
Medical Teacher	483	12	4.277	5
Nursing Education Today	468	12	3.906	11
Medical Education	417	5	7.647	4
Advances in Physiology Education*	400	22	2.396	10
Anatomical Sciences Education	387	14	6.652	10

*The journal is the core resource (classified by Bradford Law) of flipped classrooms research.

The 39 author's keywords with a frequency of 10 or more were analyzed, and VOSviewer divided them into seven clusters and formed a network connection, revealing the main areas and directions of development (Figure 5). Different colors distinguish different clusters, representing a category of research hot directions. Cluster 1 is the largest group, including 12 keywords, mainly related to active learning,

FIGURE 5
Clustering distribution of keywords co-occurrence hotspot network.
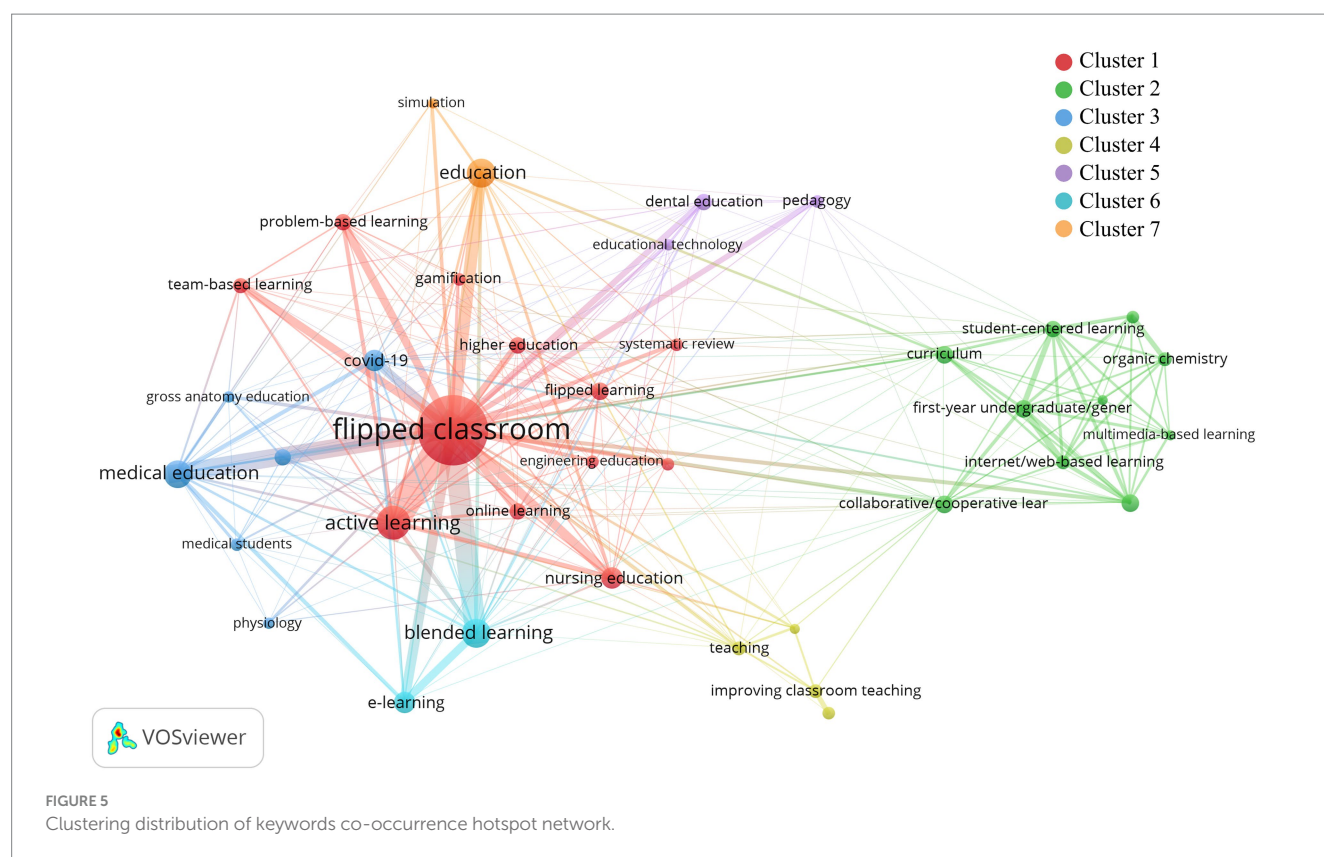
engineering education, flipped learning, nursing education, problem-based learning, and team-based learning, focusing on the learning models involved in flipped classrooms. Group 2/6 includes 12 keywords, such as collaborative/cooperative learning, multimedia-based learning, internet/web-based learning, and e-learning, focusing on modern education in the flipped classroom. Cluster 3 focuses on flipped classrooms in different contexts, mentioning COVID-19, medical education/students, physiology, and undergraduate education. Cluster 4/5 includes improving classroom teaching, learning strategies, and teaching strategies, concentrating on improving teaching strategies.

Citation classics

Table 3 shows the top-ten most cited flipped classroom-related studies. "The Flipped Classroom: A Course Redesign to Foster Learning and Engagement in a Health Professions School," published by Mclaughlin JE et al. in *Academic Medicine* in 2014, received the most frequent citations (total citation: 577). This study reports on the effectiveness of flipped classrooms compared to traditional instruction on student application in the pharmaceutics course, describing the advantages of flipped classrooms on class attendance, students' learning, and perceived value.

Trends in flipped classroom research and themes distribution

Figure 6 shows the relationship of flipped classroom-related research hotspots over time, which can reflect the trending topics of flipped classroom research. The span of the horizontal line indicates the period

of word explosion, and the circle size refers to the word frequency. Undergraduate medical education, COVID-19, and nursing dominate the top three positions in flipped classroom-related research. They will likely continue to be popular research topics as the current global outbreak is still developing. The call for educational reform is driving the development of new teaching models such as flipped classrooms, blended learning, active learning, and student-centered learning, which can also be found in the word cloud and will continue to be followed in the future.

Supplementary Figure S4 shows the distribution and future trends of current research topics related to flipped classrooms in the form of coordinates. The first to fourth quadrants represent motor, niche, emerging, declining, and basic themes. Motor themes include flipped classrooms, active learning, and blended learning, all of which have significant trends. Curriculum reform and distance learning are the cornerstones of flipped classroom research. They need to be further explored while contributing to developing flipped classroom-related research.

Discussion

The main findings of this study

The "flipped classroom" is a complete reversal of the traditional classroom teaching structure and process based on printing, which leads to a series of reforms in teachers' roles and curriculum models (Anderson et al., 2017). This study reviewed 937 flipped classroom-related papers published in the Web of Science Core Collection database and found that research involving flipped classrooms has gradually grown since the flipped classroom was reported in 2012. The COVID-19 outbreak in late 2019 has somewhat boosted the

TABLE 3 Top-ten cited flipped classroom-related studies.

Rank	First author	Title	Year	Journal	Total citations	Total citations per year
1	Mclaughlin JE	The flipped classroom: a course redesign to foster learning and engagement in a health professions school (McLaughlin et al., 2014)	2014	Acad Med	577	64.11
2	Mason GS	Comparing the effectiveness of an inverted classroom to a traditional classroom in an upper-division engineering course (Mason et al., 2013)	2013	IEEE T Educ	481	48.10
3	Gilboy MB	Enhancing student engagement using the flipped classroom (Gilboy et al., 2015)	2015	J Nutr Educ Behav	379	47.38
4	Chick RC	Using technology to maintain the education of residents during the COVID-19 pandemic (Chick et al., 2020)	2020	J Surg Educ	374	124.67
5	Baepler P	It's not about seat time: blending, flipping, and efficiency in active learning classrooms (Baepler et al., 2014)	2014	Comput Educ	355	39.44
6	Jensen JL	Improvements from a flipped classroom may simply be the fruits of active learning (Jensen et al., 2015)	2015	CBE-Life Sci Educ	337	42.13
7	Pierce R	Vodcasts and active-learning exercises in a "flipped classroom" model of a renal pharmacotherapy module (Pierce and Fox, 2012)	2012	Am J Pharm Educ	332	30.18
8	Hew KF	Flipped classroom improves student learning in health professions education: a meta-analysis (Hew and Lo, 2018)	2018	BMC Med Educ	322	64.40
9	Missildine K	Flipping the classroom to improve student performance and satisfaction (Missildine et al., 2013)	2013	J Nurs Educ	315	31.50
10	Akcayir G	The flipped classroom: A review of its advantages and challenges (Akcayir and Akçayır, 2018)	2018	Comput Educ	301	60.20

FIGURE 6
Temporal trends in author's keywords.

FIGURE 7
Historical development of flipped classroom applications.
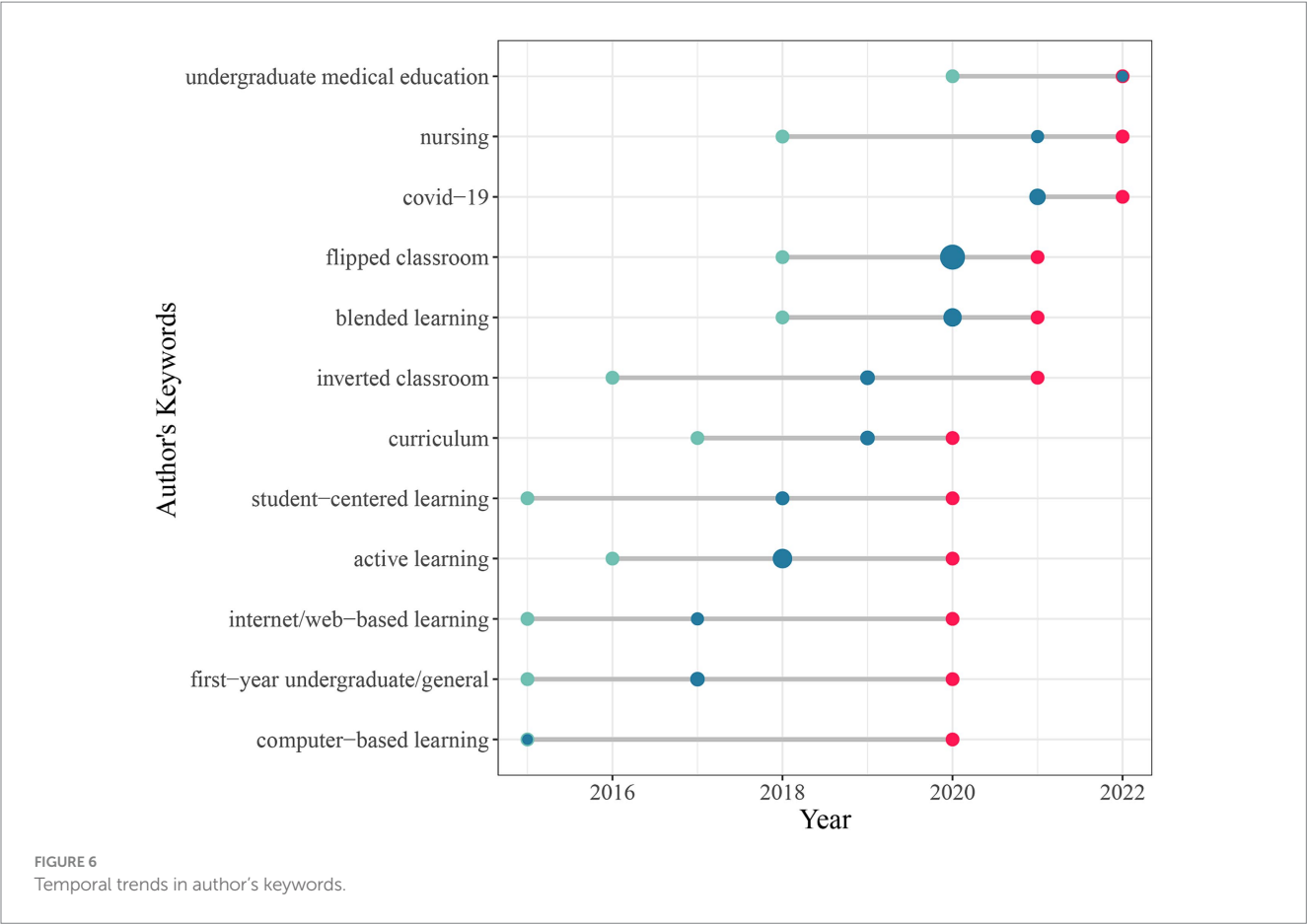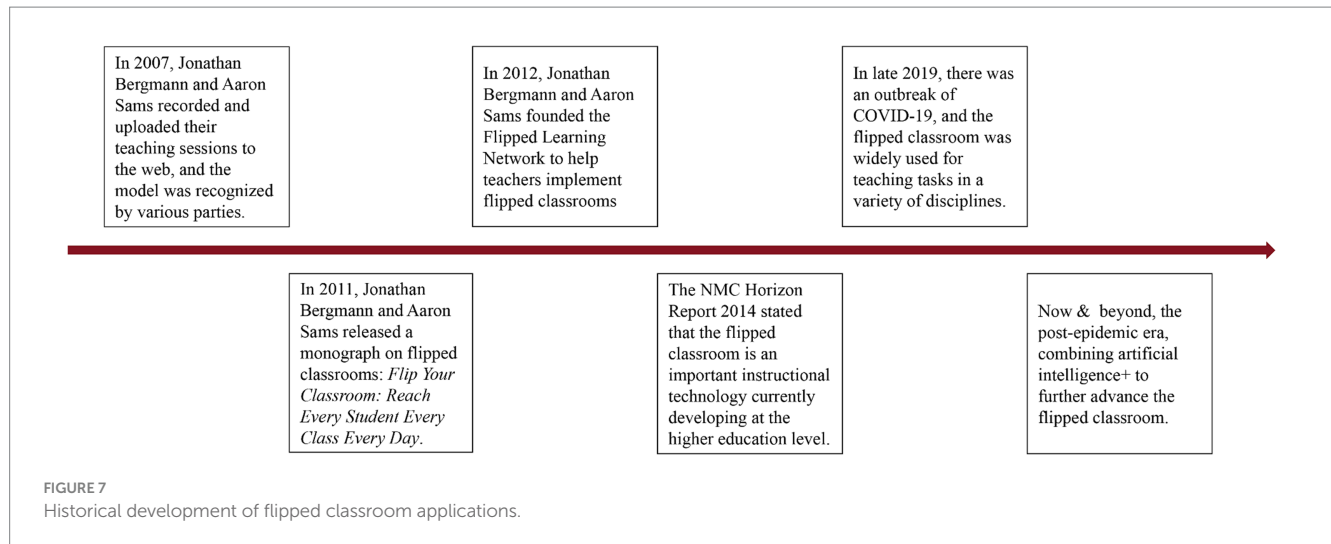
development of flipped classrooms. Therefore, we take 2020 as the boundary, and 423 (45.14%) flipped classroom-related articles were identified by Web of Science before the outbreak, while 514 (54.86%) articles were published in just three years from 2020 to 2022. Following the reports in the literature (Bergmann and Sams, 2012; Consortium, 2014), we charted an evolution of flipped classroom adoption through the perspective of historical development (Figure 7).

This new teaching model is gradually gaining attention and recognition among educators and students. Flipped classroom development varies greatly among countries, with Australia, China, Germany, Spain, and the United States leading the way. As information technology advances, the actual effectiveness of flipped classrooms versus traditional instruction will continue to be a primary research focus for educators for some time to come.

As a relatively new educational model, the flipped classroom has not yet received widespread attention from educators. Scholars from the United States, Spain, and China have some strengths in this area and dominate the research component, but collaboration between different groups is relatively sparse, which may be related to the conduct of different disciplines. For example, some researchers have applied flipped classrooms to medical education (Ruzafa-Martínez et al., 2023; Wade et al., 2023), and other educators have introduced the model to language subjects (Guo et al., 2016; Yin, 2017; Sa et al., 2022) and mechanical engineering (Cho et al., 2021). We look forward to furthering cross-collaboration to promote the development of flipped classroom-related research. Flipped classroom research is conducted worldwide, with some differences and imbalances remaining. Europe, North America, China, and Australia have more research on flipped classrooms and have significant collaborations with other countries. As more and more scholars worldwide gradually recognize the feasibility and significance of the flipped classroom, it is bound to progress and develop soon. Although the concept of flipped classrooms is relatively new, its related research is still widely accepted, and most of the flipped classroom studies are published in high-quality journals, such as *Computers & Education*, *Academic Medicine*, and *Medical Education*.

In 2011, the book "Flip Your Classroom: Reach Every Student in Every Class Every Day" was published, which officially opened the door to flipped classroom research (Bergmann and Sams, 2012). In the same year, the concept of flipped classrooms was introduced to China, and

"flipped classrooms" became a buzzword in education (McDonald and Smith, 2013; Sharma et al., 2015). Nevertheless, the research on flipped classrooms is still relatively small, and the field is still at an early stage of development, with great development space. Throughout the history of flipped classrooms, we can find that as a new teaching model, there are particular controversies, such as students' initiatives directly affecting the effectiveness of flipped classrooms (Butt, 2014; Kang and Kim, 2021); Then, for example, the use and management of technology (Moraros et al., 2015). This has also given rise to active learning facilitation strategies. On the other hand, the global popularity of COVID-19 has led to massive online education, which poses higher requirements for implementing the flipped classroom and shows the potential of flipped classroom development to some extent (Lo and Hew, 2022).

The research hotspots on flipped classrooms are relatively concentrated. The focus is on the advantages of flipped classrooms over traditional teaching (e.g., personalized learning, developing critical thinking, self-directed learning, and improving teacher effectiveness), application of flipped classrooms in different disciplines, especially medical education, and the exploration of other learning models based on flipped classrooms. After the popularity of flipped classrooms, educators have been exploring how to help students dramatically improve their performance (Rotellar and Cain, 2016). The earliest flipped classrooms were taught online through instructional videos, and this model is popular today (Oudbier et al., 2022). Later, flipped classrooms began to be integrated into the offline learning phase, an initiative to address curriculum problems encountered in online learning that could be solved at school. With the rapid development of information technology, the flipped classroom gradually entered the flipped technology phase, which means that more emphasis is placed on new approaches (e.g., audio, games) or new technologies to facilitate teacher-student interaction (Gong and Zhou, 2022; Wu et al., 2022). On the other hand, various empirical studies have proved the feasibility and necessity of flipped classrooms, which further promotes the practical approach of flipped classrooms and provides help and reference for future applications in more disciplines (Gray et al., 2022; Wen et al., 2022; Paul et al., 2023).

Healthcare providers are an essential part of the healthcare system. The world is still experiencing a severe epidemic caused by COVID-19 (Worldometer, 2022), and healthcare providers are a necessary element in the treatment process. To fulfill their role,

medical students need great expertise to face various potential problems. The flipped classroom can enhance medical students' understanding of the textbook through active learning and has become a popular and effective teaching model used in nursing (Khodaei et al., 2022), dentistry (Özcan, 2022), and pharmaceutical education (Peng et al., 2022). It is foreseeable that the flipped classroom-based teaching model will play an important role in medical education in the future (Divjak et al., 2022).

Comparison with similar studies

The current bibliometric results are like the study by Kushairi and Ahmi (2021); both indicate that flipped classrooms will gain increasing attention from practitioners, researchers, and educational scholars in the coming years. The difference is that the latter used the Scopus database to access potential literature and Lotka's Law to describe the relationship between literature and number of authors. Our study is refined to a disciplinary distribution, reporting on flipped classrooms' practicability and sustaining characteristics for different pedagogical domains. Furthermore, we mapped the keyword co-occurrence network and elaborated the research hotspots, providing pathways for future flipped classroom research.

In addition, we recognize that the current study is like another one (del Arco et al., 2022) in that it focuses on Web of Science research areas, country/region publications, published journals, and keywords, but we also present dynamic graphs, which provide more feedback on the trends in flipped classroom research, as shown in Figures 2B, 3A, 4, 6. Not only that, but we also propose several research hotspots and future study directions based on the keyword co-occurrence analysis. Interestingly, several econometric analyses on flipped classrooms illustrate the considerable research interest in this area.

Contribution of this study and future directions

The results of this study will help educational researchers understand the success of flipped classroom models worldwide and suggest avenues for further research. In addition, this study shows that significant progress has been made in teaching models based on flipped classrooms, especially in medical education. However, we can also foresee that flipped classrooms will continue to expand to other disciplines, including linguistics, mathematics, and computer science. As the flipped classroom integrates across multiple disciplines, there will be closer collaboration between researchers and even countries in the future. For the following research direction, we propose several directions. First, how to better integrate and optimize modern educational technologies, such as artificial intelligence, virtual reality, and augmented reality, to enhance the effect and interactive experience of the flipped classroom. Second, exploring the design of personalized learning paths based on student's learning styles, interests, and abilities to meet the learning needs of different students and improve learning effectiveness. Third, develop assessment and measurement tools applicable to the flipped classroom to measure the development of students' academic achievement, independent learning ability, and teamwork ability. Fourth, provide teachers with relevant training, resources, and support to help them better apply the flipped classroom teaching model.

Limitations

Although this article analyzes the research landscape of flipped classrooms from different perspectives, there are some unavoidable limitations. First, we only searched the Web of Science Core Collection database, and there are biases in the quantification and visualization of the literature, especially the citation classics, and possibly other influential articles were neglected. Second, since only two search terms for the flipped classroom were used, we may have missed flipped classroom-related articles because Jon Bergmann and Aaron Sams pioneered the flipped classroom in 2007, and there were initial attempts, whereas the earliest literature we retrieved in Web of Science was published in 2012. Third, bibliometric analysis is only an auxiliary tool, and the results may differ from real-world research conditions. Fourth, because citations change over time, bibliometric data may yield different conclusions at different points in time.

Conclusion

This review provides a comprehensive overview of the flipped classroom research field from 2012 to 2022 using bibliometric analysis. Regarding the global trends in the scientific literature on flipped classrooms, the number of publications has increased exponentially over the past decades, covering a more comprehensive range of research areas. The United States, China, Spain, Germany, and Australia are the major research countries; *BMC Medical Education* is the more authoritative journal publishing flipped classroom studies; Mclaughlin JE is the most prolific and influential author. The topic trends identified in this study indicate that flipped classroom studies data sources are becoming more abundant and cover a broader range of research areas. The focus is on the advantages of flipped classrooms over traditional teaching, the application of flipped classrooms in different disciplines, especially medical education, and the exploration of other learning models based on flipped classrooms. Future flipped classroom research could center on innovative use of technology tools and platforms, learning motivation and engagement, long-term learning effectiveness and knowledge transfer, and sustainability and implementation strategies.

Data availability statement

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

Author contributions

FZ and HW were involved in the conceptualization, design, implementation of the study, drafted, and revised the manuscript. QS and HZ have revised the manuscript. All authors reviewed the entire manuscript for editing, feedback, and approval.

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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.2024.1165547/full#supplementary-material

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