



Evidence-Based Practice in Teacher Education: The Mediating Role of Self-Efficacy Beliefs and Practical Knowledge

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European educational reforms call for the implementation of evidence-based teaching (EBT) in universities. Based on the evidence-based research paradigm in medical education, this study investigates the relationship between teacher educators' research experience, practical knowledge, self-efficacy beliefs, and frequency of EBT implementation. We report on survey data from $N = 243$ teacher educators from Germany, Austria, Switzerland, and the United Kingdom. A set of mediation analyses were run to identify the mediating role of self-efficacy beliefs and practical knowledge in the interplay among teacher educators' research experience and frequency of research evidence implementation. The results indicate that self-efficacy beliefs are a strong predictor of how frequently teacher educators implement EBT. Implications about the role of self-efficacy beliefs in teacher educators' professional learning and development along with future steps that are necessary to increase the implementation of EBT practices in teacher education will be discussed.

Keywords: teacher educators, evidence-based teaching, self-efficacy, practical knowledge, university teaching, teacher education, higher education

INTRODUCTION

The gap between research and practice in teaching has been extensively discussed in the teacher education literature (e.g., Broekkamp and van Hout-Wolters, 2007; Korthagen, 2007). Recent studies in teacher education emphasize the implementation of *evidence-based teaching* (EBT) practices as a way to bridge this gap (Slavin, 2002; Wiseman, 2010; Bauer et al., 2015). EBT and in particular research evidence is considered a vital knowledge base for teachers that can provide a sound basis for action (Davies, 1999).

The necessity for the implementation of EBT practices has been also increasingly fostered by national and international standards, which highlight the need for strengthening the professional profile of all teaching professions (European Commission, 2012). Thus, teachers are expected to use research evidence to inform their everyday school practice and to combine the evidence with their personal judgment and experience (Davies, 1999). Because teacher educators act as "the teachers of the teachers" (Kelchtermans et al., 2018), their role in fostering EBT practices in the teaching profession is of great importance (Darling-Hammond, 2016). In this study, we are particularly interested in university-based teacher educators.

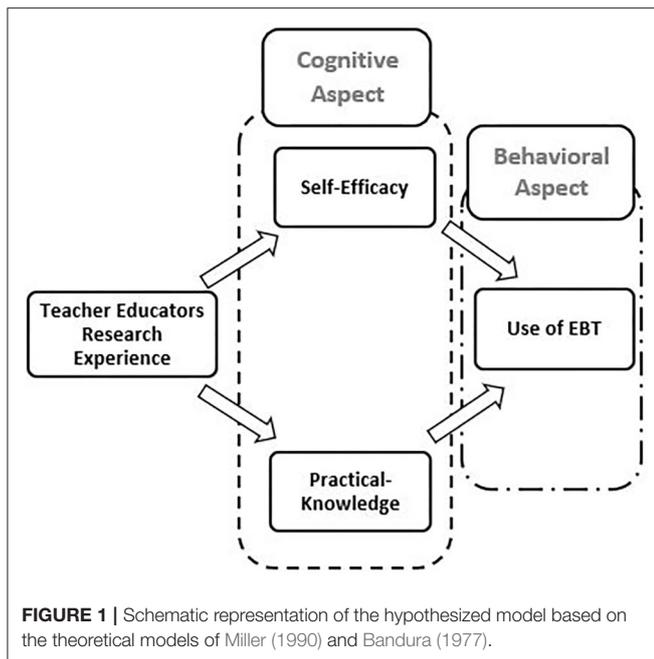


FIGURE 1 | Schematic representation of the hypothesized model based on the theoretical models of Miller (1990) and Bandura (1977).

Teacher educators are expected to be not only consumers of research but also producers (Smith, 2020). For teacher educators, research is an important developmental path (Guberman and Mcdossi, 2019) because it is crucial for their professional learning (Livingston et al., 2009). While studies on teacher educators' professional learning and development show that research plays a significant role in teacher education (Ping et al., 2018), there is little research on the personal factors that foster EBT implementation (Tack and Vanderlinde, 2014). The implementation of research evidence into teacher educators' teaching practices requires that they know about research evidence, they know how to use research evidence, and at the same time, they believe they are able to use it (i.e., self-efficacy).

In this study, two gaps in the literature are addressed: First, prior studies only focused on the investigation of school-based teacher educators' attitudes toward research (e.g., Tack and Vanderlinde, 2014); this study builds on previous literature by examining the interplay between teacher educators' research exposure and frequency of use of empirical evidence mediated by practical knowledge and self-efficacy beliefs (see **Figure 1**). Besides, we explore teacher educators' perceived challenges and facilitators to EBT in order to build a knowledge base, which can support EBT professional development initiatives targeted to teacher educators' needs.

EVIDENCE-BASED PRACTICE IN TEACHER EDUCATION

Evidence-based practice is becoming more and more important in the field of teacher education because of its critical role in teachers' professional learning and development (Wiseman, 2010; Bauer and Prenzel, 2012). Teachers and teacher educators

are expected to act upon and apply empirical evidence in their daily teaching practice (Haberfellner and Fenzl, 2017). Evidence-based practice was initially introduced in medicine in an attempt to bridge the research-practice gap (Sackett et al., 1996). Similar to medicine, the introduction of evidence-based practice in education was the result of two criticisms teaching has long faced as a profession: first, its resistance to change, and second, the discrepancy between scientific research findings and actual teaching practice (Slavin, 2002).

Defining EBT is a critical issue in teacher education and is not without controversy. Since EBT was introduced to the field of education, numerous, sometimes conflicting, definitions have been provided (Groccia and Buskist, 2011; Wrigley, 2015; Bromme et al., 2017; Stark, 2017). The main disagreement refers to the role that experience and professional judgment play in implementing evidence into teaching practice. Based on Davies (1999), one of the pioneers in the field of EBT in education, EBT is not a "cookbook" but a guiding resource that goes hand in hand with practitioners' experience. Both evidence and experience have the goal of improving teaching practice. Thus, in this study, we follow the definition of EBT by Davies, who described it as "a set of principles and practices which form the basis upon which practitioners make professional judgments and deploy their expertise" (Davies, 1999, p. 118).

Teacher Educators' Research Exposure

University-based teacher educators are a professional group who are responsible for the initial and ongoing education of pre-service teachers (European Commission, 2012; Kelchtermans et al., 2018). Identifying the role of teacher educators can be challenging since they work as mediators between the academic world, the world of teacher education, and the world of practicing teachers (Reynolds et al., 2013). In almost all European countries, becoming a teacher educator requires no formal preparation and often only minimum support from more experienced colleagues (Wilson, 1990).

Teacher educators are hired by universities based on their teaching qualifications and teaching experience (e.g., Bourke et al., 2018; Guberman and Mcdossi, 2019). Because their main task is teaching, the ones who have teaching experience in schools feel more confident since this is their chosen career, and that is the main reason they are recruited as teacher educators. However, teaching pre-service teachers about teaching is different from teaching pupils in school. Teacher educators are expected to familiarize themselves with research in the teacher education field and to engage in research in order to improve their own quality of practice (Cochran-Smith, 2005; Loughran, 2014; Vanassche and Kelchtermans, 2015).

Tack and Vanderlinde (2014) investigated school-based teacher educators' attitudes toward research and found out that active researchers have positive attitudes toward research, and because they are involved in research themselves, they contribute to the knowledge base of teacher education. This is because researchers who are also working as teacher educators are able to supervise their students' research projects to conduct their own research and to publish their findings, and, thus, they actively advance the evidence base in teacher education.

In contrast to the positive attitudes toward teaching, teacher educators' attitudes regarding professional development in research are mixed (Griffiths et al., 2014). Teacher educators with less exposure in research, especially the ones who come from schools rather than academia or the ones who are not engaged in research, feel underestimated by their colleagues and the university structures. Their lack of motivation and low self-efficacy beliefs leads them to neglect participation in research activities for the improvement of their research skills (Meeus et al., 2018).

Several challenges such as the lack of resources or skills and sometimes institutional support can lead to discrepancies between attitudes and actual behavior (Cochran-Smith, 2005; Brown and Zhang, 2016). As aforementioned, given the research exposure and academic background of teacher educators, it is expected that they will face different challenges regarding EBT implementation (Czerniawski et al., 2017). To summarize, teacher educators with higher research exposure and positive experiences in research might feel more confident about research while their counterparts might have difficulty coping as well with research (Zeichner, 2005; Czerniawski et al., 2017). To support teacher educators' EBT professional development our study sheds light on their views about the biggest challenges and incentives to increase the frequency of EBT implementation in university classrooms.

Building a Framework for Teacher Educators' Personal Factors

In the context of current EBT reforms, we discuss teacher educators' professional development from the perspective of developing teacher educators' practical knowledge and self-efficacy beliefs toward research. Since EBT has its roots in medicine, it is reasonable to build on the knowledge base of the field. Thus, the current investigation was based on two theoretical models, one stemming from medical education (Miller, 1990) and Bandura's social cognitive theory (1977) stemming from education.

Miller's pyramid has its roots in constructivism and situated learning theories and its hierarchical structure is similar to Bloom's taxonomy (Constantinou et al., 2018). This model helps to match learning outcomes with one's expectations about the abilities of the learners at any stage of their professional development. The model is usually described as having four levels: knowing, knowing how, showing, and doing. The first two levels are categorized as cognitive aspects and the second two as behavioral aspects. In order for professionals to apply new reforms such as the EBT reform in practice, they need to fulfill all four levels stated above (McKinley, 2006). In the present study, the first two levels or the cognitive aspect are investigated by measuring teacher educators' practical knowledge and self-efficacy beliefs. Also, one behavioral aspect, the "doing" level, is investigated by measuring how often teacher educators implement EBT practices in their classrooms.

The above-mentioned model can be greatly supplemented by Bandura's social cognitive theory (1977) which emphasized the major role of certain cognitive processes in encoding and

performing behaviors. Self-efficacy beliefs refer to the teacher's perceived ability and confidence to perform a given behavior (Bandura, 1977). Literature suggests that a number of parameters may affect self-efficacy beliefs (e.g., stress, well-being) among those, experiences have been identified as strongly related with teachers change (Holzberger et al., 2013). Thus, self-efficacy beliefs may change in response to teachers' previous experiences.

However, based on the aforementioned fundamental paper (Holzberger et al., 2013), social-cognitive theory goes well-beyond self-efficacy, this is why it is important to see self-efficacy in a larger framework including further cognitive determinants of behavior initiations (Lippke, 2017). Building on the theoretical model from Miller (1990), we base our study on the four different levels described above to frame our variables under behavioral and cognitive processes. Accordingly, based on the social cognitive theory (Bandura, 1977), we include experience as an important aspect interacting with self-efficacy beliefs and practical knowledge to build our mediation model. Thus, based on the aforementioned theoretical frameworks (for an overview see **Figure 1**), we expect that teacher educators' research experience affects their self-efficacy beliefs and practical knowledge which in turn impact their teaching practices (frequency of EBT use).

Teacher Educators' Practical Knowledge and Self-Efficacy Beliefs

Research on teacher educators' knowledge in practice focuses on various topics. Like school teachers, teacher educators are more in the "doing" than in the "knowing" environment (Beijaard et al., 2000); thus, it is hard for researchers to understand how teacher educators interpret, personalize, and integrate theory into action. Therefore, it is reasonable to investigate their practical knowledge, which is defined here as the amalgam of experiential knowledge, formal knowledge, and personal beliefs (Cochran-Smith and Lytle, 1999; Van Tartwijk et al., 2009).

Teacher educators are expected to know where and how to find relevant research, to be critical readers, and to know how to apply this knowledge to their own higher education teaching practice (Murray et al., 2009; Elstad, 2010). Thus, understanding teacher educators' judgments regarding their practical EBT knowledge seems to be a relevant target for EBT-related learning and professional development. Drawing on the existing literature on practical knowledge (Van Driel et al., 2001; Allas et al., 2017), it can be assumed that teacher educators' experiences can be positively associated with their practical knowledge. Additionally, changes in teacher educators' practical knowledge can support changes in teachers' educational practices. In this study, we assume that teacher educators research experience may contribute to an increase of their practical knowledge, which, in turn, would have a certain impact on the frequency they use evidence-based teaching practices.

Along with practical knowledge, it is important to understand teacher educators' self-efficacy beliefs. Self-efficacy beliefs refer to "the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific task in a particular context" (Tschannen-Moran et al., 1998, p. 233). Self-efficacy beliefs are assumed to play an

important role, along with knowledge, in one's actions (Bandura, 1997). For instance, self-efficacy beliefs are related to the way teachers teach, learn how to teach, how much effort they put into their actions (Tschannen-Moran and Hoy, 2001, 2007), and their level of commitment to teaching (Somech and Bogler, 2002; Chan et al., 2008). This is the first study to investigate the role of self-efficacy beliefs in the interplay between university-based teacher educators' research exposure and EBT implementation.

Teachers with high self-efficacy are more open to new challenges, more eager to find new methods to meet their students' needs, and generally more willing to adopt new ideas and teaching approaches (Tschannen-Moran and McMaster, 2009). Thus, we assume that highly self-efficient teacher educators are also more willing to learn and reflect on their own abilities regarding EBT. We also assume that self-efficacy beliefs will act as mediator in the interplay between teacher educators' research exposure and frequency of EBT implementation.

The Association Between Teacher Educators' Practical Knowledge, Self-Efficacy Beliefs, and Teaching Practice

Like teachers, teacher educators' practical knowledge and self-efficacy beliefs have an impact on their teaching practices and behaviors (Hu et al., 2017). Research findings suggest that knowledge and beliefs can mediate change in actual teaching practice (Hamre et al., 2012). Fives (2003) mentions that self-efficacy is the main mediator of effort and classroom action. In addition, Ernest (1989), in his descriptive model, suggests that knowledge has a direct relationship with teachers' actions in the classroom. Both practical knowledge and self-efficacy beliefs influence teachers' instructional practices; thus, it is reasonable to investigate their mediating role in relation to how frequently one implements EBT practices.

Aim of the Study

Understanding the relationship between teacher educators' research experience, practical knowledge, self-efficacy beliefs, and frequency of EBT implementation plays a pivotal role in fostering teacher educators' professional development and improving their teaching quality. This study attempts to understand whether increased research exposure can reinforce and strengthen the frequency of EBT implementation in university classrooms. We also aim to understand whether teacher educators' practical knowledge and self-efficacy can be relevant mediators in the interplay between research exposure and EBT use. In addition, we seek to understand teacher educators' views regarding the biggest challenges and facilitators to increasing EBT practices in universities. Thus, we propose the following research questions:

1. Are practical knowledge and self-efficacy beliefs mediators of the relationship between teacher educators' research experience and frequency of EBT use?
2. What are the views of teacher educators about the biggest challenges and incentives to increase the frequency of EBT use in university? Are there any differences based on teacher educators' research exposure?

METHOD

Participants

A total sample of $N = 243$ teacher educators (60% female) completed the study, with ages ranging from 23 to 68 ($M = 44$, $SD = 11.55$). The sample included teacher educators from Germany ($n = 152$), the German-speaking part of Switzerland ($n = 40$), Austria ($n = 22$), and the United Kingdom ($n = 28$). Teacher educators were recruited into the study via e-mail or through an institutional research subject pool. A total of 691 teacher educators entered the survey and 243 completed it (35% response rate). One participant did not state his or her country of origin. Research exposure was measured based on teacher educators' university position, and we identified the five following groups: school mentors (group 1: $n = 33$), teaching associates (group 2: $n = 17$), PhD candidates with teaching obligations (group 3: $n = 80$), postdoctoral candidates with teaching obligations (group 4: $n = 23$), and professors (group 5: $n = 90$). Teaching experience in the university ranged from 5 months to 43 years ($M = 11$, $SD = 8.80$).

Study Design

We used a correlational design and survey methods to quantitatively investigate the role of research experience, practical knowledge, and self-efficacy beliefs of teacher educators toward the use of evidence-based teaching practice. In addition, we explored teacher educators' views about the challenges and incentives to the use of EBT. As teacher education contexts, we chose German-speaking cultures (Germany, Austria, and the German-speaking part of Switzerland) and the United Kingdom, all of which have long histories of teacher education. Teacher educators gave informed consent before participation.

The Evidence-Based Teaching Scale

The scales and subscales used in this study were taken out of a newly developed instrument named Evidence-Based Teaching Scale (EBTS) measuring teacher educators' practical knowledge, self-efficacy beliefs, and attitudes toward Evidence-based teaching (Georgiou, 2020). Below we will provide a brief overview of the scale development, the factorial structure and convergent validity of the original evidence-based teaching scale.

A review of the literature was conducted to identify potential scales that could measure teachers' or teacher educators' knowledge, beliefs, and attitudes toward the use of scientific evidence in their teaching practice. A search was conducted in PsycINFO and Web of Science databases using the keywords "evidence-based practice" or "evidence-based teaching" combined with "knowledge," "believes," "attitudes," "measures," or "instruments." Because the first search yielded no scales for teachers or teacher educators, a new search was conducted using the keywords "evidence-based practice" and "measures" or "instruments." This search produced six potential Evidence-based practice scales and a semi-structured interview guide that have been used in medicine (for an overview see [Table 1](#)).

A three-step approach was followed for the selection of the items. This process included two expert validation faces and a

TABLE 1 | Overview of the evidence-based practice scales in medical education.

Title	No. of items	References
Evidence-based practice attitude scale	15	Aarons, 2004
Evidence-based practice questionnaire	24	Upton and Upton, 2006
Evidence-based practice beliefs scale	16	Melnyk et al., 2008
Evidence-based practice implementation scale	18	Melnyk et al., 2008
Trans-professional EBP questionnaire	66	McEvoy et al., 2010
Evidence-based practice process assessment scale	27	Parrish and Rubin, 2011
Non-skill-based attributes for evidence-based practice questionnaire	28	Johnston et al., 2003

pilot study with 30 teacher educators. After the above-mentioned process, the questionnaire consisted of 61 items in total. In detail, 47 items aimed to assess teacher educators' practical knowledge, self-efficacy beliefs, and attitudes toward EBT. Sixteen additional items developed to investigate teacher educators' frequency of and confidence in EBT practices.

For the development of the EBTS scale, an exploratory factor analysis, using principal axis factoring and an oblique rotation, was conducted on the 47-item evidence-based teaching scale for $N = 210$ respondents. The Bartlett test was significant ($p < 0.000$) and the Kaiser-Meyer-Olkin Measure of sampling adequacy ($KMO = 0.84$) indicated that the variables were suitable for factor analysis. To reveal optimal results, low loadings ($\lambda < 0.4$) or freestanding items were dropped. To decide on the adequate number of factors, the original study used the eigenvalue-criterion, the scree test and conducted a parallel analysis (Costello and Osborne, 2005). A three-factor solution showed the best fit for the analyzed data. **Table 2** highlights the factor loadings for the three factors of the evidence-based teaching scale.

Cronbach's alpha was calculated for all three scales that loaded on the three factors. The results indicate that the three scales have a good internal consistency (George and Allery, 2003). In detail, for the practical knowledge scale $\alpha = 0.84$, for the self-efficacy scale $\alpha = 0.85$, and the attitudes scale $\alpha = 0.83$. Pearson's r was used to determine the degree to which the three aforementioned factors of the evidence-based teaching scale are interrelated. Results showed moderate and significant positive correlations among the scales, supporting the notion that the variables are theoretically highly interrelated but at the same time distinct from each other. In particular the practical knowledge scale and the self-efficacy scale demonstrated the strongest relationship ($r = 0.57, p = 0.00$) while self-efficacy and attitudes the weakest ($r = 0.23, p = 0.00$).

Subscales

To examine teacher educators' practical knowledge and self-efficacy beliefs toward the use of evidence-based teaching

practices, we used the subscales practical knowledge and self-efficacy beliefs from the EBTS instrument (Georgiou, 2020). For both subscales a 6-point Likert scale was used, with 6 being the highest level of agreement. A similar 6-point Likert scale was used to measure challenges ($r = 0.20; p < 0.001$) and incentives of EBT use ($r = 0.17; p < 0.001$). Additionally, a 10-point frequency scale ($\alpha = 0.84$) ranging from 0 (no use) to 10 (EBT use ten or more times a semester) measured teacher educators' strategies of EBT implementation in a time span of a semester (example item: In the past semester how often have you a) read published research reports, b) shared and discussed literature findings with your colleagues, c) interpreted results from experimental studies).

An explanation of the term "evidence-based practice" was provided in the introduction to the survey. This way we ensured that all participants had a similar information basis regarding the EBT concept. Finally, research experience was measured based on teacher educators' university positions (a) school mentors, (b) teaching associates, (c) PhD candidates with teaching obligations, (d) postdoctoral candidates with teaching obligations, (e) professors.

Analysis Plan

Mediation refers to the effect of the independent variable (predictor) on the dependent variable (outcome) through a third variable (mediator), which mediates the relationship between the predictor and outcome. In this study, we hypothesized that teacher educators' research experience would affect their practical knowledge and self-efficacy beliefs, which, in turn, would affect the frequency of EBT implementation in university classrooms (research question 1). To test our hypothesis, we ran a step-wise mediation analyses (Hayes, 2013). As literature suggests and because our study is correlational the proposed model is not causal in nature (e.g., Sobel, 2008; Hayes, 2013; Agler and De Boeck, 2017). **Figure 2** presents the two hypothesized relationship models. The first model refers to the relationships among teacher educators' research experience and frequency of EBT implementation with practical knowledge as a mediator. While, the second model refers to the relationship among teacher educators' research experience and frequency of EBT implementation with self-efficacy beliefs as a mediator. As a third step, an overall model with both mediators added was calculated.

In the overall model, the path c is the original direct effect of research experience on frequency of EBT implementation without the mediators (practical knowledge and self-efficacy beliefs), while c' is the direct effect of research experience on frequency of EBT implementation when the mediators are included in the model. Paths a_1, a_2 and b_1, b_2 represent the effect of research experience on practical knowledge and self-efficacy beliefs and that of both mediators on frequency of EBT implementation, respectively. The product of ab is the indirect effect of research experience on frequency of EBT implementation via the mediator's practical knowledge and self-efficacy beliefs, which is commonly known as the mediation effect. Statistically, the total effect is the sum of the direct effect and mediation effect ($c = c' + ab$). For testing the mediation effect ab , we used the bootstrapping procedure in PROCESS

TABLE 2 | The evidence-based teaching scale: item factor loadings.

Item	Factor loadings		
	1	2	3
Practical knowledge of research evidence			
I know how to implement EBT	0.74		
I intend to use current research evidence when I teach a class	0.70		
I can implement current research findings efficiently	0.61		
Teaching should be based on current research evidence	0.59		
I have the skills needed to implement current research evidence in my daily teaching practice	0.56		
Implementing current research evidence is essential to reach best teaching practice	0.54		
I know how to implement current research findings sufficiently enough to make changes in my actual teaching	0.53		
Engaging in teaching based on current research evidence will improve one's teaching practice	0.51		
I know how to monitor and review my teaching skills	0.43		
I know how to identify gaps in my teaching practice	0.41		
Self-efficacy beliefs of applying research evidence			
I am able to evaluate the quality of a research study I use		0.97	
I am able to retrieve key messages from research papers		0.80	
I am able to summarize the main research findings of a research paper		0.74	
I find it difficult to implement current research evidence into my teaching practice because it is hard for me to evaluate the quality of the evidence		0.53	
I am able to determine whether research evidence is relevant to my teaching practice		0.44	
Attitudes toward evidence-based teaching			
Previous teaching experience is more important than the use of current research evidence			0.70
Teachers, in general, should not practice teaching based on current evidence because teaching is about people and students, not statistics			0.65
Teachers should decide based on their experience if and how they want to make use of current research findings			0.63
The judgment of esteemed colleagues offers a better basis than current research evidence			0.62
Experienced teachers should disregard research evidence when it conflicts with their intuition			0.61
Teaching based on current research evidence is a waste of time			0.57
There is no reason for me to implement EBT because it is just a fad that will pass with time			0.56
I know what is best for my students without examining the current research evidence			0.57
Teaching based on current research evidence ignores the "art" of teaching			0.55
My teaching experience influences how I judge evidence-based recommendations			0.46

Extraction method: principal axis factoring; Rotation method: Oblimin with Kaiser nominalization. Loadings: $\lambda < 0.4$.

model 4 macro Version 3.3 (Hayes, 2018) by obtaining the bias-corrected bootstrapped confidence interval limits. Statistical significance was confirmed if the confidence interval was greater than zero.

In addition to testing the mediation effect ab , statistical evidence for the mediating role of teacher educators' practical knowledge and self-efficacy beliefs was enhanced by comparing the total effect c (i.e., direct effect of research experience on frequency of EBT implementation without the mediator in the model) with path c' (i.e., direct effect of research experience on frequency of EBT implementation with the mediator in the

model). Statistically, if a mediator is significant, it is expected that c' would be smaller than c . Traditionally, if c' becomes statistically non-significant, this would be considered as full mediation otherwise, it would be considered as partial mediation (Baron and Kenny, 1986). Recently, the concept of full mediation is considered problematic because it excludes the possibility of other mediation mechanisms via other variables between the independent and dependent variables of interest (Pituch et al., 2005). Therefore, literature supports the idea that all mediations can be considered as partial mediations (Preacher and Hayes, 2004).

To capture any differential effects among teacher educator groups based on their research exposure, we first performed a multivariate analysis of variance (MANOVA) on practical knowledge and self-efficacy beliefs as dependent variables, with teacher educators' university rank being defined as the independent variable. Accordingly, univariate comparisons were calculated in order to explore the differences across the teacher educator groups. *Post-hoc* tests and effect sizes were also calculated for all groups using Hedge's g (Lakens, 2013). A Hedges' $g < 0.5$ was defined as a "small," 0.5 to 0.8 as a "moderate," and > 0.8 as a "large" effect size. The effect sizes for all significant differences ranged from $g = 0.3$ to 1.8.

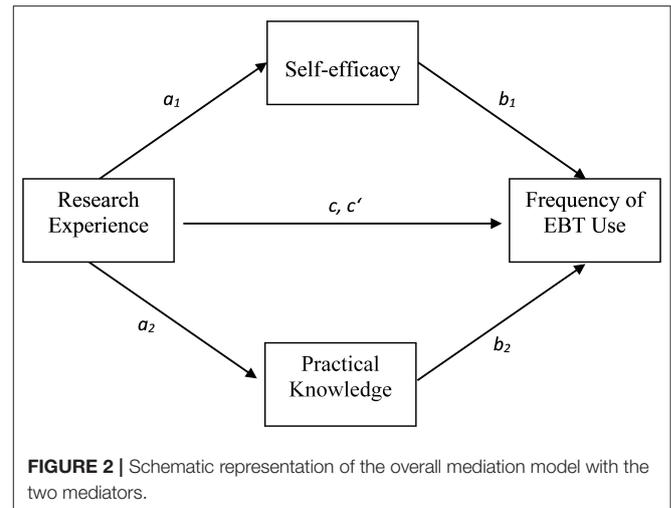
In order to answer the second research question of the study, we first descriptively analyzed teacher educators' views on challenges and facilitators of EBT use. Accordingly, we performed analysis of variance (ANOVA) on all challenges and facilitators as dependent variables, with teacher educators' research exposure defined as the independent variable. Next, we performed univariate comparisons to explore the differences across the teacher educator groups.

RESULTS

Practical Knowledge and Self-Efficacy Beliefs as Mediators Between Teacher Educators' Research Exposure and Frequency of EBT Use

The results of the mediation analyses for all three models are reported in **Figure 3**. The total effect c of teacher educators' research experience on the frequency of EBT use was statistically significant for all models. Next, a significant coefficient a relating teacher educators' research experience to the hypothesized mediators—practical knowledge and self-efficacy beliefs—was confirmed. The coefficient b for both practical knowledge ($b = 0.45$) and self-efficacy beliefs ($b = 0.32$) was statistically significant (Preacher and Hayes, 2004). The mediation effect was shown to be statistically significant ($a_1b_1 = 0.149$, $p < 0.05$; $a_2b_2 = 0.073$, $p < 0.05$). When the mediators were included in the model, the direct effect c' was still statistically significant for each of the two models ($c' = 0.31$). However, when both mediators were included in the same model, only self-efficacy beliefs remained a significant mediator.

These findings support the prediction that teacher educators' research experience is related to the frequency of EBT use in university classrooms. Furthermore, teacher educators' practical knowledge and self-efficacy beliefs function as mediators between their research experience and their practice. However, self-efficacy beliefs seem to be a stronger predictor of how frequently one uses EBT practices as compared to practical knowledge. The mediation effect of practical knowledge on the frequency of EBT use accounts for 25% of the total effect, and the mediation effect of self-efficacy beliefs on the frequency of EBT use accounts for 33% of the total effect. Thus, our hypothesis that self-efficacy beliefs act as a mediator between research exposure and frequency of EBT use is confirmed. Concerning practical knowledge, our hypothesis is partially confirmed, since practical



knowledge does not remain a significant mediator when both mediators are added in the same model.

Differential Effects of Teacher Educators' Personal Factors and Research Exposure

Table 3 shows the descriptive statistics of teacher educators' practical knowledge, self-efficacy beliefs, and frequency of EBT use for the whole sample and for every group of teacher educators based on their research experience measured by their university position. Overall, teacher educators reported to be relatively knowledgeable about EBT practices. The sample mean for the practical knowledge scale was 4.74 ($SD = 0.59$) out of a possible 6 points, with a range of 1–6. Accordingly, participants also reported rather high self-efficacy beliefs ($M = 5.10$, $SD = 0.71$) about the implementation of EBT practices. Professors reported the highest practical knowledge of the five groups and teaching associates the lowest. Professors also reported the highest values for self-efficacy beliefs, and this time school mentors reported the lowest. Teacher educators reported moderate use of EBT practices. The sample mean was 7.00 ($SD = 2.34$) out of a possible 10 points, with a range of 0–10. Professors reported to use EBT practices more often than all other groups of teacher educators, with teaching associates being the group with the lowest reported frequency of EBT use. In general, professors who were more exposed to research showed descriptively higher values for all three scales, while teaching associates and school mentors with less exposure to research reported the lowest values.

The selected teacher educator groups systematically differed regarding EBT practical knowledge, self-efficacy beliefs, and frequency of EBT use. The MANOVA showed an overall significant effect regarding group differences on EBT measures, $F_{(12,624)} = 4.67$, $p = 0.000$; Wilk's $\Lambda = 0.797$, $\eta^2 = 0.07$. Univariate comparisons (ANOVA) and follow up Tukey's HSD *post-hoc* pair comparisons revealed further significant differences across different teacher educator groups in practical EBT knowledge, $F_{(4,238)} = 5.54$, $p = 0.000$, $\eta^2 = 0.08$ and self-efficacy beliefs, $F_{(4,238)} = 10.85$, $p = 0.000$, $\eta^2 = 0.15$.

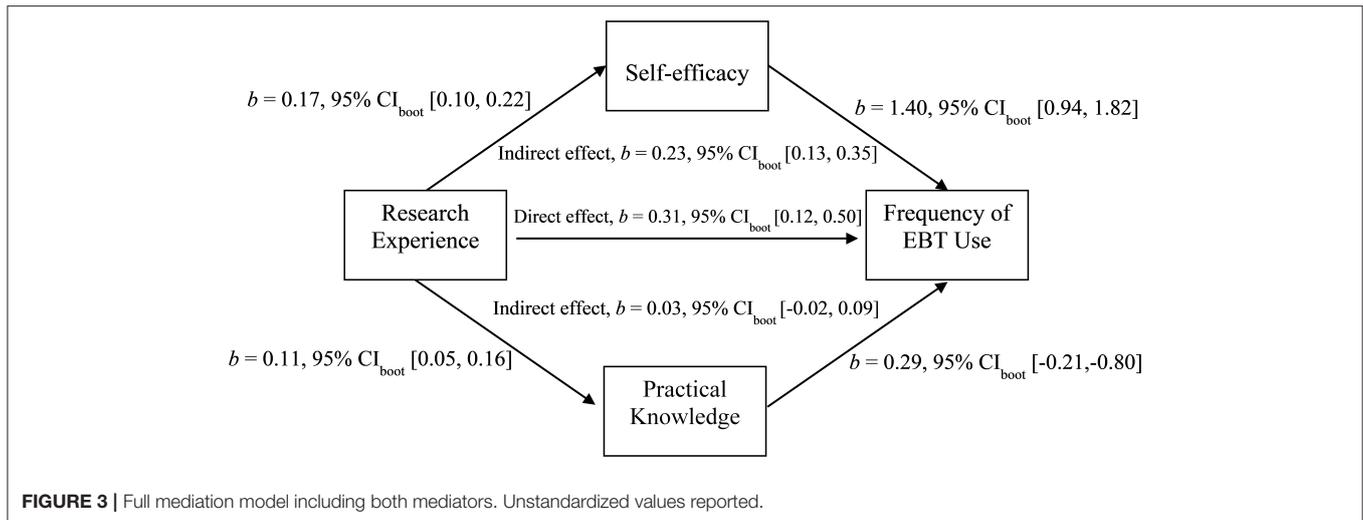


FIGURE 3 | Full mediation model including both mediators. Unstandardized values reported.

TABLE 3 | Descriptive statistics for all variables based on teacher educators' research exposure.

	Total sample (N = 243)	Professor (n = 90)	Post-doc (n = 23)	PhD Candidate (n = 80)	Teaching associate (n = 17)	School mentor (n = 33)
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
Practical knowledge	4.74 (0.59)	4.95 (0.49)	4.73 (0.44)	4.67 (0.73)	4.48 (0.46)	4.55 (0.47)
Self-efficacy beliefs	5.10 (0.71)	5.41 (0.54)	5.17 (0.55)	5.00 (0.76)	4.75 (0.71)	4.55 (0.69)
Frequency of EBT use	7.00 (2.34)	7.92 (2.06)	6.50 (2.10)	6.79 (2.28)	5.71 (2.60)	6.24 (2.19)

Scale range (practical knowledge/self-efficacy beliefs): 1 = strongly disagree to 6 = strongly agree.
 Scale range (frequency of EBT use): 0 = no use to 10 = use ten or more times a semester.

The largest effect sizes were observed for differences in EBT knowledge between professors ($M = 4.95, SD = 0.49$) and school mentors ($M = 4.55, SD = 0.47$) (Hedge's $g_s = 0.80, p = 0.000$), and between professors ($M = 4.95, SD = 0.49$) and teaching associates ($M = 4.48, SD = 0.46$) (Hedge's $g_s = 0.92, p = 0.000$). Professors practical knowledge ($M = 4.95, SD = 0.49$) also significantly differed from postdoctoral candidates ($M = 4.73, SD = 0.44$) (Hedge's $g_s = 0.44, p = 0.005$), and PhD candidates ($M = 4.67, SD = 0.73$) (Hedge's $g_s = 0.45, p = 0.000$).

For self-efficacy beliefs, the largest effect size was observed for differences between professors ($M = 5.41, SD = 0.54$) and school mentors ($M = 4.55, SD = 0.69$) (Hedge's $g_s = 1.44, p = 0.000$), between professors $M = 5.41, SD = 0.54$ and teaching associates ($M = 4.75, SD = 0.71$) (Hedge's $g_s = 1.10, p = 0.000$), and between professors ($M = 5.41, SD = 0.54$) and PhD candidates ($M = 5.00, SD = 0.76$) (Hedge's $g_s = 0.62, p = 0.000$). Significant differences were also found between postdoctoral candidates ($M = 5.17, SD = 0.55$) and teaching associates ($M = 4.75, SD = 0.71$) (Hedge's $g_s = 0.64, p = 0.004$), and postdoctoral candidates ($M = 5.17, SD = 0.55$) with school mentors ($M = 4.55, SD = 0.69$) (Hedge's $g_s = 0.95, p = 0.000$). PhD candidates self-efficacy beliefs ($M = 5.00, SD = 0.76$) also differed significantly from school mentors self-efficacy beliefs ($M = 4.55, SD = 0.69$) (Hedge's $g_s = 0.59, p = 0.000$).

Challenges and Facilitators for Achieving EBT Practices in the University Classroom

Tables 4, 5 summarize the mean overall scores for the items referring to challenges and facilitators to EBT implementation. Differences between the groups are depicted also in the tables. The findings indicate that staying up to date with the newest literature, EBT training and evidence evaluation skills were perceived as the biggest challenges to the implementation of EBT practices among teacher educators, followed by lack of critical appraisal skills. Significant differences were identified between professors and teaching associates concerning the need for EBT training, where professors scored significantly higher than their counterparts. Significant differences were also identified between professors, PhD candidates, and school mentors in regard to the evaluation skills one needs to find the best available evidence.

Regarding challenges related to time constraints, significant differences were identified between professors, teaching associates, and school mentors. Professors reported feeling more time pressured than teaching associates and school mentors. The lack of evidence in the literature and the gap between research and practice were also perceived as challenges to EBT implementation.

As for the facilitators, teacher educators reported that access to literature and critical appraisal skills are equally

TABLE 4 | Teacher educators' perceived challenges to EBT.

	Total sample (N = 243)	Professor (n = 90)	Post-doc (n = 23)	PhD candidate (n = 80)	Teaching associate (n = 17)	School mentor (n = 33)
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
1) I face a lot of time constraints that are barriers to the implementation of current research evidence into my teaching practice	3.28 (1.30)	3.62* (1.20)	3.40 (1.10)	3.15 (1.30)	2.65* (1.30)	2.90* (1.50)
2) I am not trained enough to implement current research evidence in my teaching practice	4.80 (1.25)	5.10* (1.20)	4.48 (1.30)	4.70 (1.26)	4.18* (1.30)	4.52 (1.10)
3) Poor critical appraisal skills could be a barrier to the implementation of research evidence in my teaching practice	3.60 (1.60)	3.60 (1.70)	4.13 (1.30)	3.61 (1.60)	2.94 (1.40)	3.27 (1.42)
4) The lack of research evidence in the literature is a barrier to the implementation of EBT	3.70 (1.40)	3.80 (1.45)	4.00 (1.20)	3.65 (1.35)	3.60 (1.32)	3.27 (1.50)
5) Having to stay up to date with the literature is a barrier to the implementation of current research evidence in my teaching practice	4.74 (1.20)	4.83 (1.20)	4.43 (1.40)	4.80 (1.13)	4.30 (1.30)	4.80 (1.03)
6) I find it difficult to implement current research evidence into my teaching practice because it is hard for me to evaluate the quality of the evidence	4.90 (1.00)	5.10* (1.00)	4.83 (1.00)	5.00* (1.00)	4.82 (1.20)	4.36* (1.10)

Asterisks represent significant differences between professors and PhD candidates, professors, teaching associates, professors, and school mentors.

Bold values represent significant differences between professors and PhD candidates, professors and teaching associates, and professors and school mentors.

important to the implementation of EBT. Teacher educators also reported that research experience, teamwork, and development of evidence-based databases can facilitate the use of EBT. Concerning teacher educators' research experience, significant differences were identified between professors and teaching associates, where professors scored significantly higher than their counterparts. Teacher educators did not agree with the idea that the more involved they were in the development of evidence-based databases (e.g., What Works Clearinghouse database) the more they implemented EBT practices.

DISCUSSION

The aim of the present study was to quantitatively investigate the relationship between teacher educators' research exposure and frequency of EBT implementation in the university classrooms of four different countries. Specifically, we aimed to understand whether personal factors, such as practical knowledge and self-efficacy beliefs, act as mediators in the interplay between research exposure and EBT use (research question 1). In addition, to provide better support to teacher educators' professionalization, we investigated the biggest challenges and facilitators to the use of EBT practices in universities (research question 2).

Based on the findings of our study, teacher educators generally reported high practical knowledge and self-efficacy beliefs. Research in medicine (e.g., Johnston et al., 2003) and in teacher education (e.g., Reddy et al., 2017) shows that personal

factors (e.g., knowledge, beliefs, and attitudes) are related to professionals' use of evidence in practice. This study expands research by investigating the role of two personal factors for teacher educators, namely practical knowledge and self-efficacy beliefs. In order to enrich the literature, we further aimed to explore the mediating role of both practical knowledge and self-efficacy beliefs in the relationship between teacher educators' research exposure and frequency of EBT implementation.

A significant direct association was found between teacher educators' research exposure and practical knowledge and self-efficacy beliefs, respectively. We also identified a significant indirect relationship between teacher educators' research exposure and frequency of EBT use. Our results suggest a mediating effect of teacher educators' self-efficacy beliefs on the frequency of use of EBT practices. Thus, teacher educators' self-efficacy beliefs may be an important indicator of how frequently teacher educators decide to implement EBT practices in their own teaching practice. This finding is in line with previous findings in the teacher education literature, in which the role of self-efficacy has been widely investigated (e.g., de Mesquita and Drake, 1994; Tschannen-Moran and Johnson, 2011).

Specifically, teacher education literature discusses the relationship of teachers' beliefs to teachers' planning, instructional decisions, and teaching practices (Pajares, 1992). Bandura (1993) and Pajares (1996) showed that skills, competence, and knowledge are less strong predictors of teachers' behaviors and actions while beliefs, in particular self-efficacy beliefs, drive teachers' actions. Self-efficacy is a key

TABLE 5 | Teacher educators' perceived facilitators to foster EBT practices.

	Total sample (N = 243)	Professor (n = 90)	Post-doc (n = 23)	PhD candidate (n = 80)	Teaching associate (n = 17)	School mentor (n = 33)
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
1) University teachers who are involved in creating evidence-based databases are more likely to implement current research evidence in their teaching practice	2.72 (1.10)	2.64 (1.04)	2.65 (0.71)	2.90 (1.16)	2.71 (1.30)	2.60 (1.10)
2) My teaching experience influences how I judge evidence-based recommendations	2.70 (1.00)	2.61 (1.02)	2.90 (0.82)	2.80 (1.02)	2.53 (0.80)	2.60 (1.03)
3) Easy access to evidence-based databases (e.g. clearinghouses) fosters the use of research findings in my teaching practice	4.42 (1.13)	4.50 (1.20)	4.35 (1.10)	4.40 (1.20)	3.80 (1.20)	4.64 (1.00)
4) Discussing teaching approaches with colleagues helps me to integrate current research evidence into my teaching practice	4.74 (1.10)	4.80 (1.00)	5.00 (0.90)	4.70 (1.30)	4.65 (1.32)	4.73 (0.80)
5) It is essential for me to have access to bibliographic databases and evidence sources	5.16 (1.05)	5.40 (0.93)	5.00 (1.09)	5.03 (1.20)	5.10 (0.90)	5.12 (1.02)
6) In my opinion, EBT requires the use of critical appraisal skills to ensure the quality of all the research papers retrieved	5.16 (0.92)	5.30 (0.92)	5.04 (0.93)	5.20 (0.91)	5.20 (0.90)	4.82 (0.92)
7) Being a researcher myself facilitates the use of evidence in my practice	4.90 (1.34)	5.24* (1.00)	5.00 (1.00)	4.81 (1.21)	4.24* (1.90)	4.21 (1.92)

Asterisks represent significant differences between professors and teaching associate.

Note. Bold values represent significant differences between professors and teaching associate.

construct to understand how teachers make decisions, feel, and perform at work (Vera et al., 2011). Self-efficacy is relevant for experienced teachers as well since their classroom experiences contribute to either an increase or a decrease in their self-efficacy beliefs (Holzberger et al., 2013). It also plays an important role because it works as a predictor of teachers' teaching practice and motivation to teach (Bandura, 1997). Self-efficacy is also useful for shaping cognitive judgments such as job satisfaction. Knowing how to apply something and being able to apply it in practice does not translate into job satisfaction if one does not feel self-efficacious (Moè et al., 2010).

In our study, practical knowledge seemed to be a mediator in the relationship between teacher educators' research exposure and frequency of EBT use. However, when practical knowledge was entered together with self-efficacy beliefs as mediators in the same model, practical knowledge's mediating role was not strong enough to be significant. This finding indicates that, in this interplay, self-efficacy beliefs play the most important role in the implementation of EBT strategies; knowledge or practical knowledge may be insufficient. Our research suggests that teacher educators need to feel able to apply their knowledge in order to implement EBT in their classrooms. The fact that teacher educators know how to apply basic EBT strategies does not necessarily mean that they feel able to do it. Thus, higher institutions and professional development initiatives might consider strengthening their focus on fostering teacher educators' self-efficacy beliefs.

Regarding the second research question, teacher educators reported struggling both with resource-related and knowledge-related challenges. Evaluation of the quality of evidence, staying up to date with the newest literature, and the need for evidence-based teaching training to bridge the gap between research and teaching practice were identified as the biggest challenges. These findings are in line with previous research in medicine (e.g., Sullivan et al., 2017) and in teacher education (Brown and Zhang, 2016; Diery et al., 2020), where environmental context and resources, skills, social influence, and professional role and identity are considered as relevant to change professionals' use of evidence into practice. Time pressure in combination with training needs and evidence evaluation seemed to be significantly more prevalent for professors than for teaching associates and school mentors. This is because professors have a multifaceted role in academia since they have to work as researchers, publish their work, and teach at the same time. In addition, they can spend a great amount of time working on administrative tasks, and thus they do not have enough time for teaching (Lunenberg et al., 2007), let alone keeping up with implementing evidence-based teaching.

A recent study about teacher educators' learning needs (Czerniawski et al., 2017) also emphasized the need to develop a set of skills to bridge the research-practice gap; these skills include, among others, time availability and the development of further research skills, such as critical appraisal skills. Recent initiatives that offer summaries of current findings in educational

research such as the What Works Clearinghouse in the US, the Educational Endowment Foundation in the UK or the Clearinghouse Unterricht (Seidel et al., 2017) can be of great help for teacher educators. These initiatives minimize the time one needs to search, select, rate, and decide about the best available evidence for, say, using a certain teaching strategy. Thus, they offer an easy-to-access knowledge base for teacher educators' professional development (Tack et al., 2017).

In order to tackle teacher educators' needs for EBT professional development, we also asked them about potential facilitators that could support them to use EBT practices more frequently. Our findings show that access to evidence-based databases, research exposure, critical appraisal skills, and better communication among teacher educators of all levels could facilitate the use of EBT and bridge the gap between research and practice. Similar results were reported in previous research in the health professions (Pagoto et al., 2007) and teacher education (Langley et al., 2010).

Another major finding of our study concerns the differences between teacher educators with different levels of research exposure. Although research exposure may be subject to further parameters like educators' commitment to research or self-regulation in this study we investigate educators' research experience based on their academic rank. Descriptive differences were identified among the different groups of teacher educators. Teacher educators with higher research exposure, in general, reported higher practical knowledge and self-efficacy beliefs as well as higher frequency of use of evidence into their teaching practice. This is because teacher educators who are already involved in both research and teaching are required to know how to use evidence and how to interpret it in their daily practice. On the contrary, teacher educators at the university who only teach are less exposed to ongoing research, and thus they report lower practical knowledge and self-efficacy beliefs as well as lower use of EBT practices.

Teaching associates, young researchers, and school mentors would benefit from professional development trainings to foster their research skills, such as trainings on evaluation of research studies and understanding of basic statistical methods (Lunenbergh and Willemse, 2006). University professors and highly research-exposed teacher educators who might be knowledgeable about new research evidence would benefit from trainings targeting time management skills and metacognitive processes of reflection in order to be able to make evidence-based decisions to modify teaching actions. A good example that can be used as a starting point for the advancement of professional trainings for highly research-exposed teacher educators is provided by the model of the metacognitive processes of reflection by McAlpine and Weston (2002).

Commitment to research and educators' professional development training alone cannot be sufficient if policymakers and university structures provide no changes. University structures might foster collaborations between low and high research-exposed teacher educators in order to advance young educators' self-efficacy beliefs and EBT implementation (Cochran-Smith, 2003). Policymakers, on the other hand, may consider the workload of highly

research-exposed teacher educators and provide further support by hiring lecturers with high research exposure who have the knowledge and skills to implement evidence-informed teaching practices. Therefore, future research may focus on the development of EBT professional trainings tailored to the needs of less research-exposed teacher educators.

Limitations

Although important findings were outlined in this study, several limitations must be addressed in future research to better understand which factors should be the focus of EBT professional development efforts for the heterogeneous group of teacher educators. This correlational study only measured the mediating role of practical knowledge and self-efficacy beliefs in the interplay between teacher educators' research exposure and frequency of use of empirical evidence. Teacher knowledge can include pedagogical knowledge, content knowledge, and knowledge of the learner (Shulman, 1987). Beliefs can also include self-concept and self-esteem and can also be subject-specific (Pajares, 1992). Because the role of personal factors is scarcely investigated in the teacher educators' literature, researchers are encouraged to include other mediators in the model. Moreover, experimental designs are needed to further verify our first results. Future research focusing on experimental designs will be beneficial to test the hypotheses put forward in this study and to reduce the likelihood of confounding variables. Also, interview studies may prove beneficial to investigate in-depth possible factors that affect teacher educators research experience like commitment, self-regulation or motivation.

Additionally, we used self-reported measures, which are prone to social desirability biases, a risk that must be addressed with any form of subjective data collection (Desimone, 2009). However, in the instrument development, piloting, and data collection process, measures were taken to reduce social desirability bias (e.g., assurance of "no right or wrong answers" and absolute confidentiality; exclusion of items including polarizing phrasing). With that said, the presence of response biases cannot be excluded. However, and because no ceiling effects were reported, this consideration is rather limited given the high variation expressed in the standard deviation. Further validation of the new EBTS scale is recommended for future research. Future research is also required with respect to the complexities of personal domain variables. Examining teacher educator's personal domain variables toward EBT over time, for example in two time points during an academic year, may prove beneficial for teacher educators. Such an approach may help teacher educators to better understand how personal domain variables affect their practices. This can lead to improvements in teacher education curricula in the long run and to changes regarding their understanding of evidence-informed teaching (Levin et al., 2013).

A final consideration refers to the definition and measurement of practical knowledge. We recognize that practical knowledge has been defined and measured in various ways (Clandinin, 1985; Connelly et al., 1997; Elbaz, 2018). In this study, we defined practical knowledge as the amalgam of experiential knowledge, formal knowledge, and personal beliefs (Cochran-Smith and

Lytle, 1999; Van Tartwijk et al., 2009). Based on this definition and similar studies in medical education, we developed the items of our scale. Because the role of personal factors is significant in the EBT professionalization of teacher educators, and because practical knowledge is a messy construct, future research may focus on the development of EBT instruments targeting personal factors such as practical knowledge.

Conclusion

Teacher educators belong to a heterogeneous group of teachers with various work duties, which involve either only teaching or teaching and research; thus, there is a variation on how research-exposed they are. Because of these differences, teacher educators may also experience differences in their practical knowledge and self-efficacy beliefs, differences that may affect the implementation of evidence in their teaching practice. In the interplay between self-efficacy beliefs and practical knowledge, self-efficacy plays a more important role concerning EBT implementation in practice than knowledge; the fact that teacher educators know how to apply EBT practices seems to be less significant to EBT implementation. Like teachers, teacher educators need to feel able to implement certain practices (in this case, EBT practices) in order to apply them in practice.

Moreover, because teacher educators come from different backgrounds, they have different needs for professional development. To design trainings tailored upon their individual needs, it is important to understand the challenges teacher educators face and the potential facilitators that could foster EBT use. University structures may consider investing in professional trainings for less research-exposed teacher educators to boost their self-efficacy. This measure, along with possible collaborations between high and low-experienced teacher educators, could further support teacher educators' EBT professional development and EBT implementation. Finally, as in medicine with the Cochrane library (Jadad and Haynes, 1998), successful application of research evidence to teacher education can be fostered with the support of evidence-based databases such as the clearinghouse databases in the USA and Europe.

Our research provides first insights on teacher educators' practical knowledge and self-efficacy beliefs regarding their evidence-informed professional development. Although we are not yet able to provide readymade solutions for the improvement

of their EBT skills, we contribute to the scarce literature in this field by establishing a knowledge base for teacher educators' further professional development. We hope that this initial work will spark interest and stimulate further studies on teacher educators' competencies such as practical knowledge and self-efficacy beliefs which can contribute largely in teacher's instructional quality (e.g., Kunter et al., 2007).

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The present study was approved by The Ethics Commission of the Faculty of Psychology and Educational Sciences at the LMU Munich. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

DG conceived of the presented idea, designed the study, directed the project, developed the measurements, collected the data, processed the survey data, performed the analysis, drafted the first version of the manuscript, designed the figures and tables, and took the lead in writing the final manuscript. SM and TS were involved in planning and conceptualization. SM, TS, FF, and JV contributed to the interpretation of the results and review and edit the first written draft. All authors provided critical feedback and helped shape the final manuscript.

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

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