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What should teacher educators know about technology? Perspectives and self-assessments

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HIGHLIGHTS

- A cross-disciplinary sample of teacher educators assessed themselves on the 12 TETCs.
- The participants ($N = 336$) generally rated themselves highly across all of the TETCs.
- TETC self-assessments differed by participants' subject, grade level, and experience.
- Not all participants perceived a need for high levels of competency for all TETCs.
- Some participants felt the TETCs could better define purposeful, effective technology use in teaching.

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ABSTRACT

This article offers a first look at teacher educators' ($N = 336$) perceptions of their technology competencies based on the Teacher Educator Technology Competencies (TETCs; Foulger, Graziano, Schmidt-Crawford, & Slykhuis, 2017). The participants generally rated their competence levels highly in relation to the TETCs. Although many participants reported that the TETCs adequately reflected the competencies required of them, they suggested various additions and changes to the TETCs. This mixed-method study advances understanding of teacher educators' perceptions of the importance of various competences to their work and offers feedback from the field regarding which competencies might be missing from the TETCs.

1. Introduction

The United States' (U.S.) most recent *National Education Technology Plan* (U.S. Department of Education, 2017) exhorted teacher education programs to rethink prospective teachers' preparation to use technology in their future classrooms. In response, Foulger et al. (2017) developed the *Teacher Educator Technology Competencies*

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(TETCs; Table 1). The competencies—as well as the idea of competencies specifically for teacher educators—are new. There are examples of technology competencies for teachers, including those from the *International Society for Technology in Education* (ISTE), and many content area associations in the U.S. (e.g., *National Science Teachers Association*) mention technology in their standards for teacher education programs; however, the TETCs are the first set of technology guidelines specifically for teacher educators. As such, the TETCs are a notable set of guidelines for the teacher education field (Nelson, Voithofer, & Cheng, 2019), particularly given that technology is a cross-cutting theme defined by the *Council for the Accreditation of Educator Preparation* (CAEP), the largest U.S. teacher education program accreditor.

Although teacher education programs have often delegated responsibility for technology instruction to a standalone educational technology course, such an approach has its limitations (e.g., Moursund & Bielefeldt, 1999), and the TETCs' creators envisioned the 12 competencies as the expertise "*all* teacher educators need in order to support teacher candidates as they prepare to become technology-using teachers" (Foulger et al., 2017, p. 413). As digital technologies are now ubiquitous, teacher educators' abilities to build on prospective teachers' existing skills and support sophisticated use of technology have taken on greater importance (Instefjord & Munthe, 2017; Kay, 2006). Furthermore, it is commonly assumed that teacher educators do not possess enough technological expertise, in particular with emerging or advanced technologies (Georgina & Olson, 2008; Uerz; Volman, & Kral, 2018).

Building upon the development of the TETCs, we, a multi-institutional and international group of teacher educators with expertise in educational technology and teacher education research, sought to provide an account of teacher educators' self-reported technology competencies that can serve as a foundation for further research and initiatives designed to support teacher educators as they prepare prospective teachers to use technology. We also aimed to advance understanding of teacher educators' perceptions of the relative importance of various competencies and to share feedback from the field regarding which competencies might be missing from the TETCs. Knowledge of teacher educators' perceptions of the TETCs and their technology competencies can inform efforts to frame and facilitate professional development, anticipate opportunities and challenges for the use of the TETCs, and suggest whether or how the existing TETCs defined by Foulger et al. (2017) should be used or modified. Therefore, this mixed-methods study was guided by the following research questions:

1. How do teacher educators assess themselves on the TETCs?
2. What do teacher educators report as being the most and least important TETCs in relation to their work?
3. What are the relationships between teacher educators' assessment of their TETCs and years of teacher education and K-12 teaching experience, subject matter, and grade level of teachers prepared?
4. What do teacher educators report as being important to their work that is not reflected in the TETCs?
5. How does nominating a TETC as being among the most and least important relate to teacher educators' self-assessment of competency for that TETC?

2. Background

The TETCs present an opportunity to explore whether teacher educators believe they possess the knowledge, skills, and dispositions necessary to prepare educators for the present and future educational landscapes (Foulger et al., 2017). While prospective and practicing teachers' technology competencies have been the topic of copious research, the technology competencies of teacher educators have received much less attention (Taimalu & Luik, 2019). Teacher educators are important role models for prospective teachers in various ways (Lunenberg, Korthagen, & Swennen, 2007), including for technology use (Baran, Canbazoglu Bilici, Albayrak Sari, & Tondeur, 2019; Tondeur et al., 2012). Their capacity to serve as role models for technology integration is likely related to their technology competencies, with at least some minimal level of competence necessary.

The TETCs were created through a three-stage process (Foulger et al., 2017). The TETC research team reviewed existing literature related to teacher educator and technology competencies to identify themes. The literature was gathered by a crowdsourcing approach that relied upon a call for literature sent out through various teacher educator networks. Next, the research team facilitated a Delphi study with participants ($N = 17$) from U.S. and Australian universities to modify and build upon the themes from the literature. Delphi studies involve expert panels engaging in multiple rounds of deliberation regarding a complex problem or topic in order to come to a consensus (Clayton, 1997). Finally, the research team made an open call for public comments on an initial draft of the competencies and made revisions based on the gathered feedback. This call was distributed to Society for Information Technology and Teacher Education conference attendees and shared with additional organizations and individuals via email and social media posts (Foulger et al., 2017). This multi-stage, multi-year process resulted in a set of 12 competencies (Table 1), and each one includes between two and five related criteria that offer more details regarding the competency. The related criteria can be found at http://site.aace.org/tetc.

Nelson et al. (2019) described the TETCs' introduction as "an

Table 1
Teacher educator technology competencies.

1. Teacher educators will design instruction that utilizes content-specific technologies to enhance teaching and learning.
2. Teacher educators will incorporate pedagogical approaches that prepare teacher candidates to effectively use technology.
3. Teacher educators will support the development of the knowledge, skills, and attitudes of teacher candidates as related to teaching with technology in their content area.
4. Teacher educators will use online tools to enhance teaching and learning.
5. Teacher educators will use technology to differentiate instruction to meet diverse learning needs.
6. Teacher educators will use appropriate technology tools for assessment.
7. Teacher educators will use effective strategies for teaching online and/or blended/hybrid learning environments.
8. Teacher educators will use technology to connect globally with a variety of regions and cultures.
9. Teacher educators will address the legal, ethical, and socially-responsible use of technology in education.
10. Teacher educators will engage in ongoing professional development and networking activities to improve the integration of technology in teaching.
11. Teacher educators will engage in leadership and advocacy for using technology.
12. Teacher educators will apply basic troubleshooting skills to resolve technology issues.

important step in teacher education research" (p. 332). The TETCs allow for measuring or enhancing technology competence across the teacher education field in unique ways. However, teacher educators' perspectives on these competencies and how they relate to their work need to be investigated further, as teacher educators can respond to guidelines and standards like the TETCs by embracing, adapting, or resisting them (Bourke, Ryan, & Ould, 2018). Teacher educators' responses may play a key role in determining the TETCs' effects and fate. For example, if large numbers of faculty in some content areas dismiss the TETCs' relevance, the TETCs may fail to gain widespread traction. Furthermore, knowledge of teacher educators' perceptions of their competencies on the TETCs is valuable because it can serve as a point of comparison for other teacher educators and teacher education programs to reflect upon their competencies.

While new, the TETCs' authors wrote that they developed them in light of theory and research, including the technological pedagogical content knowledge (TPACK) framework (Mishra & Koehler, 2006; Niess, 2005). The complex, multifaceted conception of knowledge reflected in the TPACK framework suggests that effective technology integration would require a diverse array of competencies of teacher educators, including an understanding of contextual factors that may affect technology use. The TETCs themselves provide the bulk of the framing for this study. Like the TETC authors, we believe that defined standards and competencies can prove useful to teacher educators by informing instruction, curriculum, and professional development (Foulger et al., 2017). The TETCs are predicated on the idea that a single technology course is insufficient preparation for prospective teachers to use technology (Foulger, Buss, Wetzel, & Lindsey, 2012; Mishra & Koehler, 2006) and that technology must, therefore, be infused across teacher education programs (Foulger et al., 2017). The TETC authors cite research (e.g., Agyei; Voogt, 2011; Polly, Mims, Shepherd, & Inan, 2010) that suggests a critical factor influencing new teachers' technology use is their experiences with technology during their teacher preparation programs. In a departure from the TETC authors' conception of these competencies, we were open to the idea that not *all* teacher educators necessarily need high levels of competency for *all* of the TETCs (see Di Blas, Paolini; Sawaya, & Mishra, 2014). Thus, we explored whether our participants perceived some TETCs as being more or less important to their work.

3. Review of the literature

Through university degree programs and professional development (PD) activities, teacher educators are tasked with equipping current and future teachers with the knowledge, skills, and dispositions to meet all of their students' needs (Avidov-Ungar & Forkosh-Baruch, 2018). At a time when technology is rapidly changing and deeply embedded in society, teacher educators must support teachers in designing and implementing diverse curricula and innovative pedagogies that leverage technology, while also preparing them to be critical regarding potential problems associated with technology such as data privacy issues (Krueger & Moore, 2015), cyberviolence (Nagle, 2018), digital divides (Warschauer, 2004), problematic algorithms (Noble, 2018), and the intensification of teachers' work (Selwyn, Nemorin, & Johnson, 2017). Furthermore, teacher educators cannot simply model technology use; they must also justify that use in relation to other factors like learning goals, content standards, and student needs (Uerz, Volman, & Kral, 2018).

Teacher educators can serve as catalysts for educational reforms. However, it is frequently asserted that many teacher educators lack the technology competencies required of them (Mims, Polly, Shepherd, & Inan, 2006; Krumsvik, 2014; Uerz et al., 2018). For example, Tondeur Roblin, van Braak, Fisser, and Voogt (2013) investigated the technology integration efforts at three teacher education programs via interviews with both prospective teachers ($N = 26$) and teacher educators ($N = 16$). Despite these programs shifting away from standalone educational technology courses, it still appeared that prospective teachers were not receiving adequate preparation to use technology, and the authors suggested that faculty needed PD to become effective TPACK role models. Voogt and McKenney (2017) interviewed 12 teacher educators regarding the use of technology for early literacy, and the participants identified their limited technology competencies for early literacy as a substantial barrier to technology integration in their programs. While other factors may present challenges to developing teachers' technology knowledge and skills—such as limited opportunities for field experiences with practicing teachers who use technology in sophisticated ways (Polly et al., 2010)—teacher educators' technology competencies are arguably related to prospective teachers' learning (Krumsvik, 2014; Voogt; McKenney, 2017).

Teacher educators' technology competencies may be related to their academic disciplines and their experience levels. Subject matter has been shown to affect classroom technology integration in various studies at the K-12 level (Howard & Maton, 2011; John & La Velle, 2004), and the cultures and traditions of different subjects that influence K-12 educators likely also have some influence in teacher education contexts. For example, early childhood teacher educators in Voogt and McKenney (2017)'s study did not consider particular technologies as relevant to them because they perceived that those technologies were not used in early childhood classrooms. Furthermore, recent research has also suggested that teacher educators' technology-related knowledge may vary according to their academic discipline. Nelson and colleagues' (2019) survey of U.S. teacher educators ($N = 806$) found that their self-reported TPACK levels varied significantly across subject areas. However, as Nelson et al. (2019) noted, their work preceded the release of the TETCs and did not specifically address those competencies. In the case of experience levels, prior research related to technology competence has yielded inconclusive results, underlining the need for further exploration. For example, some studies have found that more experienced teachers have lower levels of knowledge related to some aspects of educational technology use (e.g., Jang & Tsai, 2012; Liang, Chai, Koh, Yang, & Tsai, 2013), but in other research, experience levels have not been found to be associated with significant differences (e.g., Baek, Jung, & Kim, 2008; Nelson et al., 2019).

Although there is potential for improving teaching and learning through pedagogically sound technology use, this potential has at times been elusive (Aagard, 2015; Cuban, 2003; Palak & Walls, 2009). Research suggests that teachers often use technology to support existing practices rather than to transform them (e.g., Project Tomorrow, 2017; Tondeur, Kershaw, Vanderlinde, & van Braak, 2013). Teacher educators and teacher education programs help shape how teachers do and do not use technology in their classrooms. Yet, teachers are not always given the support, training, and experiences they need to integrate technology in ways that lead to improved student outcomes. While stereotypes of young people as digital natives might suggest that novice teachers possess an innate technology fluency, researchers in multiple countries have suggested that many prospective teachers leave their teacher education programs with insufficient technology-related knowledge and skills (Angeli & Valanides, 2009; Ertmer; Ottenbreit-Leftwich, 2010; Gudmundsdottir; Hatlevik, 2018; Haydn, 2014). Even when technology is integrated across multiple courses, the types of technologies and experiences available may not prepare teachers for using technology in transformative ways with their students (Wetzel, Buss, Foulger, & Lindsey, 2014). Indeed, a study of nearly 1400 prospective teachers found that the main technologies they learned in their methods courses were primarily used for delivering content, writing, and analyzing data rather than generating authentic, student-empowering learning (Project Tomorrow, 2013).

The knowledge and skills required for technology integration are complex, as teachers must understand how to synthesize effective instructional strategies with content area expertise and appropriate technologies (Mishra & Koehler, 2006). Prospective teachers require guidance and support to overcome the barriers that inhibit technology integration, such as time, resources, attitudes and beliefs, and lack of experience, knowledge, and skills (Ertmer, 1999). Ultimately, without sufficient role models, opportunities for practice, or contact time with various digital tools, teachers often feel ill-equipped to use technology (Chien, Chang, Yeh, & Chang, 2012; Tondeur et al., 2012). Furthermore, the rapid changes in digital technologies and the diversity of digital platforms utilized by different school districts create challenges for teacher education programs' and teacher educators' abilities to predict the exact knowledge and skills that will prove most useful several years down the road.

Given the challenges of improving teachers' technology use, scholars have sought to identify what competencies teacher educators need to support teachers' technology integration. Uerz et al. (2018) analyzed the literature related to teacher educators' competencies for teaching and learning with technology. They identified four domains of competence—technology, pedagogical and educational technology use, beliefs about teaching and learning, and professional learning—but found, overall, that the empirical research base is under-developed. Uerz and colleagues concluded that further research was needed both on the specific competencies needed by teacher educators and the extent to which they possess those competencies. Instefjord and Munthe (2017) concurred that research on teacher educators' digital competence is lacking. The same authors also suggested little is known about how teacher educators' perceive their roles in relation to technology competence. Accordingly, they surveyed teacher educators ($N = 387$) from 19 teacher education programs across Norway regarding their perceptions of their digital competence, although not specifically in relation to the TETCs. The participants rated themselves most highly regarding their understanding of the use of digital tools to promote student learning and their ability to serve as role models for the use of digital tools for teaching, and lowest regarding their competence in using interactive whiteboards and digital tools for assessment.

Referring specifically to the TETCs, Nelson et al. (2019) recently suggested that "there is currently a gap in the literature in understanding [teacher educators'] capacities to meet these new skills and what factors influence these capacities" (p. 331). Thus, this study attempts to further the research base with an empirical investigation on teacher educators' self-reported technology competencies. This research is important because it offers insights into 1) teacher educators' sense of their technology competencies and 2) their perceptions of a recently promulgated set of competencies that will likely be taken up by teacher educators and teacher education programs in different ways (Bourke et al., 2018). Understanding how teacher educators view the TETCs, along with knowledge of how they rate their technology competencies, can help researchers, administrators, policymakers, and the TETCs creators as they consider how the TETCs might be utilized, amended, or further studied to benefit the teacher education field as well as the preparation, development, and support of teacher educators.

4. Research method

4.1. Instrument

To examine teacher educators' competence with educational technology and their perspectives on the TETCs, we created an anonymous online survey using a commercial survey tool. The survey's design was informed by the TETCs themselves, prior literature on educational technology (Ertmer & Ottenbreit-Leftwich, 2010), and quality criteria for online surveys (Dillman, Smyth, & Christian, 2014). The 10-person research team undertook three cycles of survey drafting, discussion, and revisions before soliciting expert feedback (Olson, 2010) from scholars in educational technology and teacher education. The survey included closed- and open-ended items. Six items gathered respondents' demographic information and information about their roles as teacher educators. In this article, we focus on responses to a set of items that asked respondents to rate themselves on the TETCs on a 5-point Likert-type scale [1]with scale points that ranged from "Not competent" to "Highly competent." For our analyses, we treated this data as continuous based on our use of multiple items (12) for teacher educators' TETC confidence and the availability of five response categories (Harpe, 2015). The midpoint of the scale was "competent"; we chose to use this (instead of omitting it and using a forced-choice scale) because respondents could evaluate themselves as simply being competent as a valid response (rather than being not or highly competent for a given TETC). We also focused upon three open-ended prompts that probed respondents' perceptions of the TETCs and how they relate to their work.

4.2. Data collection and sources

We distributed the survey via multiple channels in an attempt to gather data from a wide variety of teacher educators. Each team member was responsible for contacting teacher educators in their networks. These invitations requested that recipients consider completing the survey, as well as sharing it with other teacher educators. Invitations included specific language encouraging responses from teacher educators who do not consider themselves technology experts. These direct contacts were logged in a central spreadsheet to avoid overlap in invitations. Research team members also recruited participants for the study at professional conferences they attended in person as well as via social media postings to relevant Twitter hashtags, Facebook groups, and online forums. Data collection was undertaken for approximately two months. In total, 336 teacher educators responded to the survey.

4.3. Missing data

For the 336 responses, the sample contained no missing responses related to TETCs or the grade levels (e.g., K-6) of teachers prepared by the teacher educators. There was some missingness for other items. For years of experience in K-12 and teacher education settings, 6.6% ($n = 20$) and 0.6% ($n = 2$) of responses were missing, respectively, so these observations were therefore not included in analyses related to experience. While not missing, an item for what content area teacher educators prepared future teachers included an option for participants to select "not applicable." For that item, 13.6% ($n = 46$) of respondents chose this "not applicable" option, and these observations were not included in subsequent analyses related to content area.

[1] Likert-type scale items were coded from 1 to 5, rather than 0–4.

4.4. Participants

Out of 336 respondents, 212 (62%) indicated they worked with both prospective (pre-service) and practicing (in-service) teachers, with 88 (26%) working only with prospective teachers, and 36 (10%) working only with practicing teachers. On average, the participants had 11.08 years ($SD = 7.46$) of experience teaching in PK-12 classrooms and 11.96 years ($SD = 8.54$) of experience as teacher educators. The largest group of respondents, approximately 40%, were tenured faculty (Table 2). Most responses came from U.S.-based teacher educators, though some were from teacher educators in other countries.[2] The respondents reported preparing prospective teachers at a wide range of grade levels (Table 3). In terms of academic subjects (Table 4), science was the most common subject (reported by approximately 23% of respondents), followed by technology, English language arts, mathematics, and history/social studies.

4.5. Measures

Before analyzing the quantitative data, we first examined the measurement properties of the TETCs. Specifically, we wanted to understand whether the 12 TETCs exhibited unidimensional measurement properties (i.e., all 12 TETCs measure one underlying characteristic or factor) or whether they measured multiple characteristics. To do so, we first explored the bivariate Pearson correlation coefficient between the 12 TETCs, which were found to be positively correlated, with coefficients ranging in value from 0.28 to .77.[3] Next, we carried out an exploratory factor analysis using the minimum residual ordinary least squares estimation method with oblimin rotation for solutions with a varying number of factors using the *psych* (Revelle, 2018) R package. Because the statistic that is most commonly used to determine the number of factors (the eigenvalues for each factor) indicated that there was only one factor (see Fig. S1), we carried out a parallel analysis and examined the optimal coordinates and acceleration factor values via the *nFactors* R package (Raiche, 2010). This analysis also indicated that the TETCs measured only one underlying factor (see Fig. S2). The proportion of variance explained by the single factor was 0.52. The factor loadings are presented in Table S1. For the single factor, we created a composite variable for the mean of the 12 TETCs (Cronbach's $\alpha = 0.92$), which we used in the analyses for RQ 1 and RQ 3. In addition to this composite measure, the measures used in the analyses are described in Table 5. For grade level and subject, we grouped the responses into the values reported in the last column (see the coding scheme for the mutually exclusive codes for grades in Table S3 and the coding scheme for the mutually exclusive codes for subjects in Table S4).

Table 2
Participants' current professional positions.

Answer	% of Respondents	Count
Tenured faculty	39.8%	134
Tenure track (probationary) faculty	22.9%	77
Non-tenure track faculty	16.6%	55
Other	10.4%	35
Graduate student	5.9%	20
Administrator	4.5%	15
Total	100%	336

Table 3
The types of teachers prepared by participants.

Answer	% of Respondents	Count
Elementary/primary teachers	70.8	238
Secondary/high school teachers	70.5	237
Middle grades/junior high school teachers	68.2	229
Early childhood teachers	32.1	108
Other	15.8	53

Table 4
Participants' subject or content area specialization(s).

Answer	% of Respondents	Count
Science	22.6	76
Technology	21.7	73
English/Language Arts	21.1	71
Other	18.8	63
Mathematics	16.7	56
History/Social Studies	14.9	50
Special Education	14.0	47
Physical Education & Health	5.1	17
Music	4.2	14
Fine Arts	3.9	13
World Languages	3.9	13
Career Technical Education	2.1	7

4.6. Data analysis

To understand how teacher educators assessed their competencies for RQ1, we examined the mean and standard deviation for the 12 TETCs individually and as a composite. We used R (R Core Team, 2019) for this analysis and all subsequent analyses involving quantitative measures. For RQ2, to identify which TETCs teacher educators reported as the most and least important to their work, three members of the research team conducted a thematic analysis of the qualitative data (Braun & Clarke, 2006). First, we reviewed a subset of the data together to identify a tentative code structure. We then individually coded another subset of the data, reconvened to discuss their interpretations of the codes and the data, and reconciled differences of interpretation. We divided the remaining qualitative data among the three researchers, so there was a first and second reader for each response. We coded all of the responses and the first and second readers reconciled any discrepancies in coding. Then we engaged in iterative discussions of emergent themes and drafting summaries for those themes. Due to the interpretive nature of this type of analysis, we relied upon intensive group discussion and group consensus to reach agreement upon codes and themes, rather than on an inter-rater reliability statistic (Saldaña, 2015).

To determine relations between teacher educators' competence and the grade-level and academic subject matter of the teachers they prepare for RQ3, we focused upon overall mean ratings on the 12 TETCs, rather than on specific TETCs. To do so, we used a one-way ANOVA; if the ANOVA indicated the presence of statistically significant differences, a post-hoc analysis (using the Hochberg technique, which can balance type-1 and type-2 error rates better than the Bonferroni technique) was used to determine which specific grade-level or subject matter groups differed from one another. For these analyses, we first checked the assumptions for the use of the ANOVA method: independence of observations,

[2] Mapping of location data for survey submissions indicated that apart from the United States ($n = 275$), responses were gathered from Australia ($n = 15$), Great Britain ($n = 9$), Canada ($n = 7$), Ireland ($n = 6$), Israel ($n = 3$), and 11 additional countries with one response each: Argentina, Chile, Czech Republic, Denmark, Germany, India, Nepal, Norway, New Zealand, Peru, and Sweden. We were unable to obtain location information for nine responses.

[3] See Table S1 for the Pearson correlation coefficients for the bivariate relationships among the 12 TETCs.

Table 5
Descriptions of the quantitative measures used in this study.

Measure	Description	Type of Variable	Range/Eligible Values
TETC composite	The average of teacher educators' responses to the 12 individual TETC items	Continuous	1–5
Years of K-12 teaching experience	Years of the teacher educators' experience in K-12 settings	Continuous	0–30
Years of teacher education experience	Years of the teacher educators' experience in teacher education	Continuous	0–30
Subject	The subject(s) of the teachers that teacher educators prepare	Categorical	Technology, science and math, humanities and special education, and other
Grade level	The grade level(s) of the teachers that teacher educators prepare	Categorical	All (grade levels), secondary, elementary, and other

Note. While the TETC that teacher educators report as most and least important to their work are used in quantitative analyses, they come from qualitative measures and so are not reported here.

homoscedasticity, and the normality of residuals. To determine relations between teacher educators' competence and their years of experience, we used Pearson correlations.

For RQ4, we carried out a qualitative analysis of participants' responses to an item asking about what they found to be important that was not included in the TETCs. We used an analysis process similar to that described above for RQ2. Finally, to understand how selecting one of the TETCs as among the *one or two most and least* important and reporting being competent were related for RQ5, we again used Pearson correlations (in this case, a point-biserial correlation, as selecting a TETC as among the most and least important is a dichotomous variable).

5. Results

5.1. RQ1: How do teacher educators assess their technology competencies?

First, we found the composite variable of all 12 TETC items was 3.63 ($SD = 0.83$). In Table 1, we present the means and standard deviations of the 12 individual TETC items, the most and least important percentages, and the correlations between an individual's indication that a TETC is among the most and least important of the TETCs and individuals' ratings of their TETC competence. Fig. 1 also represents the means and standard deviation of the 12 TETC items graphically.

5.2. RQ2: What do teacher educators report as being the most and least important TETCs?

5.2.1. Most important TETCs

Respondents were asked to explain one or two technology competencies that they considered most important to their work. In most cases ($n = 271$, 80%), participant responses were associated with one or more of the 12 TETCs (Table 6). Three competencies were mentioned with noticeably greater frequency than the other nine: #2 ($n = 65$, 19%), #3 ($n = 55$, 16%), and #4 ($n = 50$, 15%). These three competencies are arguably among those TETCs that are most general and applicable to a wider variety of teacher educators. However, even for these three TETCs, none was mentioned as most important by more than 20% of the participants. Three TETCs (#6, #8, #11), which are considerably more specific, were identified by relatively fewer respondents as being among the most important competencies for their work. Each competency was seen as being of high importance by at least 10 respondents.

Ninety (33%) participants also mentioned one or more competencies that were important but that were not one of the existing TETCs; these included specific technologies, skills, knowledge, and more general mindsets or dispositions. Thirty-five participants (10%) identified skills such as "Online search strategies for resources" and "Distinguishing reliable sources of information." Twenty-five participants (7%) mentioned specific technologies that they considered important to their work as teacher educators. For example, 11 participants noted the importance of familiarity with Google products, and several respondents also referred to the importance of competence regarding particular learning management systems such as Blackboard.

Seventeen (5%) teacher educators mentioned the importance of mindsets or dispositions related to technology. For example, one respondent underlined the importance of being "open to changes and learning by doing." Several participants directly or indirectly referred to the need to accommodate the rapid pace of change with digital technologies. Another group of responses focused on having a more critical mindset towards technology. For instance, a participant argued for "mindfully incorporating tech instead of teaching to use an item of tech. The last university I was at was all iPADS [sic] all the time and then when our students went into the field they were faced with Chromebooks." Finally, 11 participants (3%) referenced specific technology-related knowledge. For example, two teacher educators mentioned the importance of being aware of the technologies available in their partner K-12 schools.

5.2.2. Least important TETCs

Another survey item asked participants to explain the one or two technology competencies that they considered of low or no importance to their work (Table 6). The largest group of respondents indicated that they perceived all of the TETCs to be important ($n = 88$, 26%), while additional participants responded that they were unsure ($n = 14$, 4%) or with an "n/a" ($n = 9$, 3%). Almost a third of respondents therefore did not identify a TETC they considered as being of low or no importance. Six TETCs (#1, #2, #3, #4, #5, #10) were mentioned by fewer than 3% of respondents as being of low or no importance to their work. The frequency of responses that defined particular TETCs as being of low or no importance was often the inverse of the frequencies for TETCs defined as most important. For example, TETC #11 was *most* frequently mentioned as being of low or no importance, just as it had been *least* frequently mentioned as being most important. In addition to #11, more than 10% of participants mentioned #12 "Teacher educators will apply basic troubleshooting skills to resolve technology issues" and #8 "Teacher educators will use technology to connect globally with a variety of regions and cultures" as being of low or no importance to their work.

Many participants offered explanations for why they considered a TETC to be less important. Sixty-two (19%) indicated that a particular TETC was not as important to their work because of the content or courses they taught or because other teacher educators

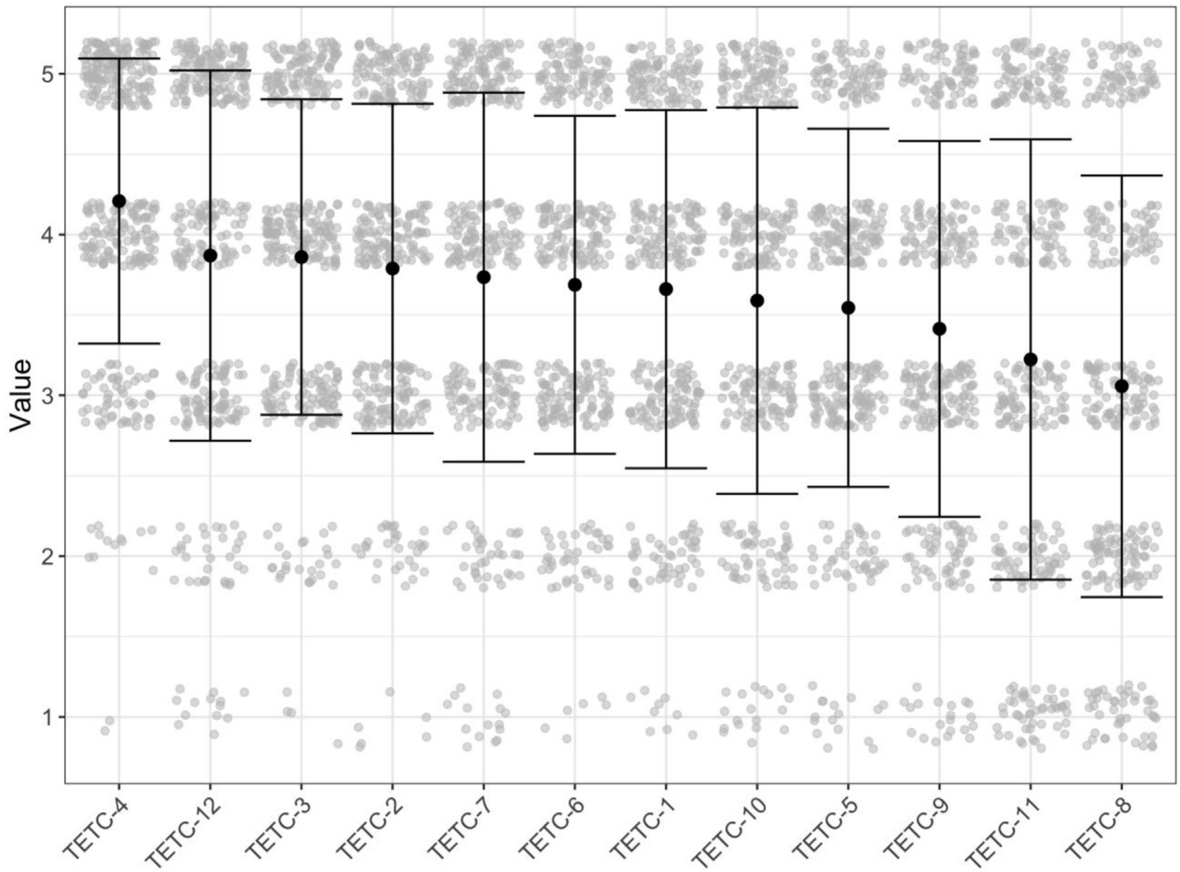

Fig. 1. Teacher educators' assessments of their technology competencies. Note. Each grey point in the figure represents an individual response to the survey. The responses are jittered vertically and horizontally to avoid overplotting. The mean is represented by the black point, and the standard deviation is represented by the confidence interval.

Table 6
Participant perceptions of most and least important TETCs and their self-assessments of competence.

Teacher educators will …	Most Imp (%)	Least Imp. (%)	TETC Level (*M* [*SD*])	Most Imp. (*r*)	Least Imp. (*r*)
1. Design instruction that utilizes content-specific technologies to enhance teaching and learning.	10.09	1.19	3.66 (1.11)	0.09+	−0.09
2. Incorporate pedagogical approaches that prepare teacher candidates to effectively use technology.	19.29	1.19	3.79 (1.03)	0.17*	−0.09
3. Support the development of the knowledge, skills, and attitudes of teacher candidates as related to teaching with technology in their content area.	16.32	2.97	3.86 (0.98)	0.10+	−0.08
4. Use online tools to enhance teaching and learning.	14.84	0.0	4.21 (0.89)	−0.12*	NA
5. Use technology to differentiate instruction to meet diverse learning needs.	10.09	2.67	3.54 (1.11)	0.07	−0.20*
6. Use appropriate technology tools for assessment.	5.93	4.45	3.69 (1.05)	0.11*	−0.13*
7. Use effective strategies for teaching online and/or blended/hybrid learning environments.	9.50	5.93	3.74 (1.15)	0.19*	−0.21*
8. Use technology to connect globally with a variety of regions and cultures.	3.56	9.79	3.06 (1.31)	0.18*	−0.17*
9. Address the legal, ethical, and socially-responsible use of technology in education.	8.30	3.56	3.41 (1.17)	0.18*	−0.12*
10. Engage in ongoing professional development and networking activities to improve the integration of technology in teaching.	9.79	1.78	3.59 (1.2)	0.16*	−0.16*
11. Engage in leadership and advocacy for using technology.	2.97	14.24	3.22 (1.37)	0.12*	−0.27*
12. Apply basic troubleshooting skills to resolve technology issues.	5.93	12.17	3.87 (1.15)	0.08	−0.07

Note. +p < .10, *p < .05, **p < .01, ***p < .001. The column headings Most Imp. (*r*) and Least Imp. (*r*) refer to the correlation between an individual nominating a TETC as among the most or least important and an individual's self-assessment on that TETC.

were responsible for addressing the competency. For the TETC related to connecting globally (#8), multiple participants explained that it was not central or relevant to their particular courses. One participant wrote, "The challenge is that there is so much to cover and connecting to others across the world for projects is time consuming," while another commented, "For the course that I teach, connecting globally is not a necessary component." Among respondents who considered it of relatively low importance for them to address legal, ethical, and socially-responsible technology use (#9), some stated that such matters were or should be addressed in another course. For instance, one individual wrote, "While I think this is important, this should be addressed in a technology course that introduces students to instructional strategies that enhance teaching and learning." Other participants did not consider this competency as particularly relevant to their course content. A mathematics teacher educator wrote, "I have given minimal emphasis to discussion of ethics in technology use. My students are using on-line tools with their own data, not communicating with or investigating those outside our class."

For the competency related to leadership and advocacy for using technology, two main explanations were offered for defining it as being of lower importance. Some respondents indicated that others were better positioned or able to provide such leadership. One teacher educator explained, "I leave the leadership and advocacy for using technology to the tech gurus." Another group of participants questioned the fundamental notion of providing leadership and advocacy for technology. One participant stated, "It is important to bring a critical lens to the use [of] digital tools for teaching and learning, and to support pre- and in-service teachers to do the same … I would not advocate for using technology simply for the sake of using technology."

Fifty participants (15%) referred to technology competencies that we did not associate with one of the TETCs. Some respondents ($n = 27$, 8%) referenced how learning about particular technologies was not an essential competency. Participants sometimes referred to technologies by name, saying, for example, "I don't think it is important that teachers know how to use SmartBoards" and "I want our students to be product-agnostic: word processing, not Word, spreadsheets, not Excel and so on." Another wrote that "there are technologies in elementary literacy education that I don't support. These tend to be ways technology has reduced reading development to low-level skills." Fifteen participants (4%) referred to skills they considered of low or no importance to their work and six (2%) described knowledge they considered as low or no importance.

Finally, in response to the prompt regarding TETCs of low or no importance, 15 participants (4%) critiqued the TETCs. The most frequent critiques targeted the competency related to engaging in leadership and advocacy ($n = 7$, 2%). For example, one individual wrote,

> I don't think engaging in leadership and advocacy for the use of technology is what I should be doing. I advocate for good teaching. Many times, technology expands what we can do as teachers and what our students can do and learn. Other times it is not useful and can be counterproductive.

5.3. RQ3. What are the relationships between teacher educators' assessment of their TETCs and years of experience, subject matter, and grade level of teachers prepared?

We found that years of K-12 teaching experience was significantly and positively related to teacher educators' self-reported technology competencies ($r = 0.16$, $p = .004$) as measured by a composite of the 12 TETC items. Years of teacher education experience was positively associated with teacher educators' technology competencies, but the relationship was not statistically significant ($r = 0.10$, $p = .070$).

For grade, Levene's test for homoscedasticity revealed that the variance in the composite of the 12 TETC items was statistically significantly different between the groups. As a result, we used Welch's heteroscedastic *t*-test instead of an ANOVA, which assumes that the variance between the (grade-level) groups was equal. This test was statistically significant ($F(3, 130.0273) = 10.523$, $p < .001$), so we calculated the mean and standard deviation for each grade-level group (left panel, Fig. 2) and then examined which grade-level groups differed using a post-hoc technique with a Hochberg adjustment. Teacher educators of teachers at all grade levels reported the highest overall ratings of their competence ($M = 3.82$, $SD = 0.80$), which was higher than that reported by those in the elementary group ($M = 3.19$, $SD = 0.69$, $p < .001$). Those in the other ($M = 3.63$, $SD = 0.871.21$, $p = .041$) and secondary ($M = 3.60$, $SD = 0.801.21$, p = .019) groups also reported higher ratings of their competence than elementary teacher educators. The other and secondary groups were not significantly different from each other in the ratings of their competence.

For subject, the ANOVA (again with the TETCs as the outcome) with subject matter as the grouping factor was also statistically significant ($F(3, 285) = 19.57$, $p < .001$), so we calculated the mean and standard deviation for each subject matter group (right panel, Fig. 2). We then examined which subject matter groups differed from one another using the same post-hoc technique applying the Hochberg method as for grade. Teacher educators who teach technology content ($M = 4.33$, $SD = 0.87$) reported higher competence levels than those who teach other subjects ($M = 3.83$, $SD = 0.80$, $p = .004$) as well as those who teach science and math ($M = 3.47$, $SD = 0.82$, $p < 0.001$). Those who taught other subjects reported higher competence levels than those who teach science and math ($p = .019$) as well as those who teach non-STEM courses ($M = 3.34$, $SD = 0.80$, $p < .001$), such as those in the humanities and special education.[4]

5.4. RQ4: What is important to teacher educators' work that is not reflected in the TETCs?

An open-ended item asked participants to provide information on what is important in their work related to educational technology that is not reflected in the TETCs. Some participants ($n = 41$, 10%) stated that the TETCs reflected all critical elements related to educational technology that are part of their work. For example, one participant stated that "the TETCs seem comprehensive, and I do not see areas not covered." Forty-nine participants (12%) indicated they were not sufficiently familiar with the TETCs to judge or did not know if there were any key elements missing. However, 61 participants (15%) believed that the effective use of technology for teaching is not adequately reflected in the TETCs. The effective use of technology referred to the application of instructional design practices and technology integration models, as well as purposeful technology use. For instance, one participant commented that in the TETCs, "There is no recognition of the basic issues involved in design: What is the cognitive model of achievement that this activity/assessment is based upon? Do I agree with that model? Does it align with my goals?" Another participant wrote, "Unstated in the TETCs is how to differentiate between bad and good technology use or at least good, better, and best uses. Terms like 'appropriate' are used to ignore the issue, but teachers need to be taught how to incorporate technologies in ways that move beyond passive learning." Thirty-three participants (8%) mentioned social uses of technology as lacking sufficient presence in the TETCs. Such responses referenced the importance of community creation, sharing of resources, learning networks, and collaboration between teacher educators.

There were additional less frequently mentioned themes in the responses regarding elements missing from the TETCs. These included attention to mindsets or dispositions towards technology ($n = 25$, 6%), learning about new technology resources ($n = 24$, 6%), digital and media literacy ($n = 21$, 5%), the teaching context ($n = 20$, 5%), content-specific technology ($n = 20$, 5%), evaluation of technology for teaching ($n = 18$, 4%), social justice ($n = 10$, 2%), and research-based use of technology ($n = 9$, 2%). Some of the responses

[4] The non-STEM courses category includes the humanities (i.e., social studies and English/Language Arts) as well as Special Education in part because we found that mean TETC confidence was nearly the same (and was statistically indistinguishable) between special education (M = 3.34, SD = 1.17, n = 24) and the humanities (M = 3.33, SD = 1.15, n = 73). We note that there are many important differences between these fields and this choice was made to make the quantitative analysis as parsimonious as possible, while not glossing over important differences.

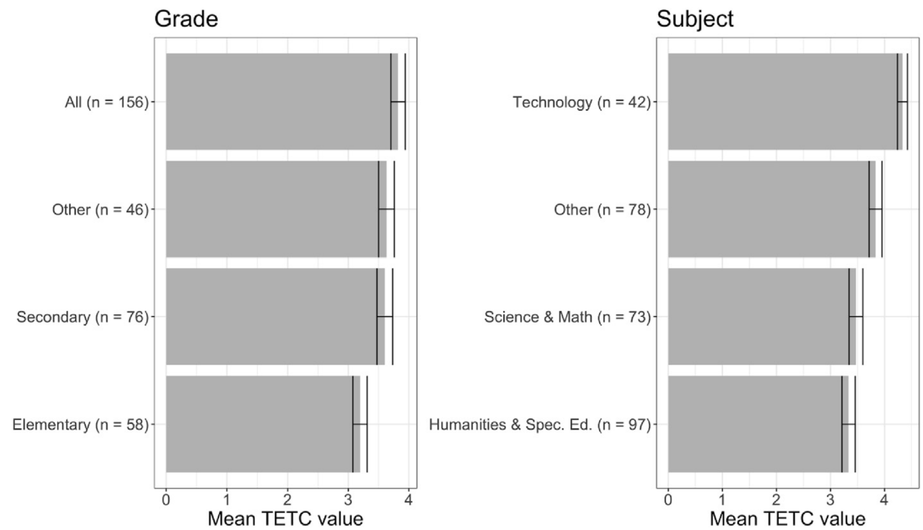

Fig. 2. Relationships between TETCs and grade level and subject matter of teachers prepared. Note. The subject codes do not sum to the number of observations ($n = 336$) because a "not applicable" option was selected in 46 responses which were not included in this analysis.

provided by the participants referred to elements that are arguably present in the TETCs. For example, several mentioned that content-specific technology was a key aspect missing from the TETCs; however, TETC #1 addresses the use of content-specific technology.

5.5. RQ5. How does nominating a TETC as being among the most and least important relate to teacher educators' self-assessment of competency for that TETC?

The Pearson correlations between nominating a TETC as important and reporting competence for that specific competency are reported in Table 6. Not surprisingly, *overall*, selecting a TETC as being among the most important and reporting competence on that TETC were positively related, with TETC #7 ($r = 0.19$) and TETCs #2, #8, and #9 (all $r = 0.18$) being most strongly related. Selecting a TETC as being among the least important and TETC levels were, overall, negatively related, with TETC #11 ($r = -0.27$) and TETC 7 ($r = -0.21$) being most strongly related.

6. Discussion

Drawing upon a large, cross-disciplinary sample, we sought to understand teacher educators' perspectives on the TETCs and how they self-report their competence with educational technology. We measured participants' perceptions of what is more and less important about the TETCs to anticipate opportunities and challenges for the use of the TETCs, including for purposes of feedback and reflection. We looked at relationships between teacher educators' competence as measured by the TETCs and the subject areas and grade levels of the courses they teach and their years of K-12 and teacher education experience, as well as how nominating a TETC as being among the most (or least) important related to their self-reported competence. Finally, we tried to ascertain what may be missing from the TETCs. Although limited by its reliance upon self-report data, our research addresses identified gaps in the literature regarding the "specific competences teacher educators need" and "the extent to which teacher educators have these required competences" (Uerz et al., 2018, p. 22). Additionally, our findings offer teacher educators' perspectives on the recently promulgated TETCs that have been highlighted as a potentially useful set of guidelines for the field (Nelson et al., 2019). These perspectives on the TETCs matter because teacher educators will influence the TETCs' effects based upon how they respond to, take up, resist, and adapt them (Bourke et al., 2018).

The participants in this study considered themselves broadly competent in their use of technology. The sample appeared to rate themselves more competent than did the sample of Norwegian teacher educators who participated in Instefjord and Munthe's (2017) study. That our sample reported relatively high levels of competence with technology is intriguing considering the body of research that suggests many prospective teachers leave their teacher education programs unprepared to use technology in innovative ways (Angeli & Valanides, 2009; Ertmer & Ottenbreit-Leftwich, 2010; Tondeur, Kershaw, et al., 2013). These findings may reinforce the conclusions of previous studies, which suggested that factors beyond individual faculty members' competencies, such as opportunities to see technology use modeled in the field (Polly et al., 2010), also affect how prospective teachers develop their technology competencies (Drent & Meelissen, 2008). Because of such factors, teacher educators who are highly competent with technology in many regards may have limited influence on the technology competence of the teachers with whom they work.

Teacher educators may sometimes be sufficiently technologically competent, but barriers may not allow them to leverage that competency to maximum effect. That almost a fifth of the participants indicated that a particular TETC was not as important because of the content they taught or because other teacher educators were responsible for addressing it is consistent with Tondeur, van Braak, Siddiq, and Scherer's (2016) recent suggestion that some teacher educators, even if they generally endorse the value of technology, may not consider it compatible with their subject area or teaching methods. Furthermore, teacher educators may not just need technology competencies but also various supports to make use of those competencies (Nelson et al., 2019), as has been shown to be the case for K-12 educators (Inan & Lowther, 2010).

While teacher educators' technology competencies matter, those competencies are not the sole factor influencing their prospective teachers' future technology use. Teacher education programs could take a multi-pronged approach that is, for example, intentional about technology integration across teacher education curricula and includes technology-rich clinical experiences with high-TPACK mentor teachers (Polly et al., 2010). Solely focusing on enhancing individual teacher educators' technology competencies may not produce the desired results. It is important not to miss other important internal and external influences on teacher educators' work with technology. For example, creativity, trust, courage, sensitivity, decisiveness, spontaneity, and flexibility are all qualities that could mediate how effectively teacher educators utilize technology and prepare prospective teachers to do so (Korthagen, 2017). External factors could include contextual supports and barriers, and even what teacher educators' peers do with technology. For example, elementary teacher educators may have reported lower TETCs because of different emphases in their standards and aims as teacher educators. However, such internal and external factors are not the focus of the TETCs.

Within the context of the general technology competence that teacher educators reported, we noted differences by experience, grade level, and subject matter. Broadly, teacher educators with more experience at the K-12 and higher education levels reported greater competence regarding particular aspects of using technology. Teacher educators with more K-12 experience reported more competence for differentiating instruction; addressing legal, ethical, and socially-responsible use; and leading with technology. Perhaps teacher educators developed these competencies—at least in part—through working in K-12 settings. Consistent with prior research from K-12 contexts (Liang et al., 2013), participants with more higher education experience reported being *less* competent at applying basic troubleshooting skills. Teacher educators who prepare prospective teachers at all levels and, generally, those who prepare teachers for upper-grade levels (i.e., middle and high school) reported greater competence overall than those who prepare teachers at lower-grade levels (i.e., early childhood and elementary). Moreover, those who teach technology and science and math education-related courses reported greater competence, overall, than those who prepare teachers in non-STEM fields. These findings align with prior research indicating that the technology competency of teacher educators may vary by content areas and K-12 and teacher education experience levels (Chapman & Gaytan, 2009; Howard & Maton, 2011; Nelson et al., 2019). Awareness of associations between teacher educators' demographic characteristics and their reported technology competencies may also help teacher education leaders consider potential ways to provide targeted or differentiated support for TETC development to different teacher educators.

What teacher educators considered most and least important was also noteworthy and adds insight to the original Delphi study Foulger et al. (2017) convened to develop the TETCs. Our respondents had diverse opinions regarding which TETCs were or were not important to their work. This likely reflects, to some extent, the diversity of teacher educators' roles. Teacher educators within and across institutions have various assigned responsibilities that might lead to them prioritizing particular competencies. For example, the work of some teacher educators is more associated with particular academic content areas, and such individuals might see the first TETC as more important given its mention of "content-specific technologies." Conversely, not all teacher educators see themselves as teaching primarily or at all in "online and/or blended/hybrid learning environments," and such respondents would thus be unlikely to prioritize that TETC. Therefore, a lack of unanimity regarding which TETCs were most important could reflect diverse job types more than fundamental disagreements in the profession regarding the importance of different competencies.

Respondents did not seem to universally concur that all teacher educators need to be highly competent with every TETC. While it may be a laudable goal for all teacher educators to possess such a diverse set of competencies, pragmatic consideration of the many demands placed upon teacher educators may require that some individuals prioritize acquiring or advancing particular competencies over others. Teacher education programs may opt to be strategic in developing distributed competence among their faculty (see Di Blas, Paolini, Sawaya, & Mishra, 2014), such that multiple faculty across a program achieve high levels of competence in each of the TETCs but not expecting every individual to become a master of all 12. This underscores a key idea related to educational technology and teacher education: not every teacher (or teacher educator) needs to be an expert in every technology. Instead, as the TPACK framework highlights, it is more important for teachers and teacher educators to use technologies to help them to work toward broader goals.

While educational technology experts played the leading roles in the creation of the TETCs, the TETC authors noted that experts in various content areas would be critical to the TETCs' adoption (Foulger et al., 2017). Our large sample allowed us to draw on the perspectives of many such content area experts. Consideration of what is *not* represented in the TETCs and was suggested by participants as important provides an example of the value of such perspectives. The topic of social justice, for example, may be especially important as technology is used in more parts of our lives and in education; societal challenges and inequalities may be perpetuated through technology rather than mitigated by its use (Nagle, 2018; Noble, 2018), and teacher educators should arguably be competent in preparing prospective teachers to use technology in ways that do not harm already marginalized groups and exacerbate achievement and opportunity gaps.

Teacher education programs and the education field generally may also need to consider appropriate goals and supportive contexts regarding beginning teachers' abilities to use technology in innovative ways. In areas such as classroom management or content knowledge, beginning teachers are not expected to be master teachers as they grow in their effectiveness during their early career (Henry, Bastian, & Fortner, 2011), so it may be reasonable to expect that their initial technology use might not always be sophisticated either.

6.1. Limitations and recommendations for future research

A limitation of this study concerns asking teacher educators to self-report their TETC levels. Regarding the participants' generally high ratings of their competence, it is important to acknowledge that some teacher educators may have a difficult time evaluating their technology expertise. For instance, when rating their competence, were the teacher educators in our sample considering emerging or more complicated technologies for which they could lack knowledge or exposure (Voogt and McKenney, 2017; Uerz et al., 2018)? Additionally, the relative newness of the TETCs could have meant that some participants' familiarity with the TETCs was limited. Participants' responses could be positively biased due to participants wanting to be proficient in these elements and thus over-reporting their competence. Nonetheless, self-reported perceptions of competence (which are self-beliefs related to one's ability that are task- or activity-specific) remain useful; they are similar and theoretically linked to self-efficacy for using technology (Fernet, Guay, Senécal, & Austin, 2012; Ryan & Deci, 2000), a key variable related to actual technology integration (Al-Awidi & Alghazo, 2012; Ertmer & Ottenbreit-Leftwich, 2010). As a result, educator self-reports on technology competence have been relied upon in other recent studies (e.g., Instefjord & Munthe, 2017; Nelson et al., 2019). While the large sample was a strength of this study, it is not a probability sample that is intended to be representative of the wider teacher education community. Lastly, while many quantitative effects (such as the difference between teacher educators who prepare teachers at all levels to those who prepare elementary teachers) were statistically significant, the magnitudes of some of the effects were not very large. However, we note that the techniques we used were intended to mitigate the detection of spurious effects, so we do not think those found are likely to be due to chance.

This study's limitations suggest opportunities for future research. It may be helpful to survey teacher educators on *other* items along with the TETCs to understand other dimensions—perhaps those that are based upon self-reports of specific, objective actions—to provide additional insight into teacher educators' reports of their technology competence. Observational or performance assessment measures of competence could also be useful for triangulating teacher educators' reports of their competence (Nelson et al., 2019). Classroom observations could reveal how teacher educators utilize and engage in explicit modeling of their technology competencies (Instefjord & Munthe, 2017). Future research could also explore the extent to which teacher educators with higher composite TETCs levels are more capable of preparing prospective teachers to integrate technology effectively.

Individuals with greater technology affinity and competency may be over-represented in our sample. The use of social media to solicit survey participation may have influenced who responded. Future research can deliberately study teacher educators who use technology less in order to reveal patterns of and reasons for technology use and non-use among teacher educators, a topic that has been the focus of study at the K-12 level (Aagaard, 2015) but less so at the post-secondary level. For instance, it would profit the field to understand better the relationship between and relative importance of perceived TETC levels and perceived importance of TETCs. Furthermore, our sample appeared to be dominated by participants from wealthier countries where access to technology may be more ubiquitous. Teacher educators in other countries may perceive technology competencies differently, and comparative research could thus benefit the field. Future research could examine the external and internal factors that may prove to be important assets and barriers for teacher educators' development and implementation of technology-related competencies (Ertmer, 1999), in the same spirit as research at the K-12 level on how teachers' *context* shapes their teaching and technology use (Rosenberg & Koehler, 2015).

6.2. Implications for practice

This investigation on teacher educators' perceptions of the TETCs has various implications for practice. First, the use of the TETCs as a context for individual teacher educator reflection allows individuals to identify areas for growth. Second, to have a clearer understanding of what higher levels of competencies look like, new tools, rubrics, or case studies could be developed with examples of increasingly sophisticated demonstration of technology competence. Third, in light of findings indicating that participants did not perceive all of the TETCs to be important and relevant to their work, we think that administrators and teacher educators themselves can think of teacher educators' work more broadly. Thinking both of teacher educators as individuals *and* about the context in which they work could help to highlight factors beyond individuals' competencies that might affect technology integration and prospective teachers' technology competency development (e.g., Drent & Meelissen, 2008). Fourth, the work that has been done exploring the distribution of TPACK among individuals (Di Blas et al., 2014) provides a way in which similar work with the TETCs may be considered. Although the goal of all teacher educators reaching high levels of competence in all areas defined in the TETCs may provide a valuable target, it could also prove unrealistic in some cases. A more pragmatic approach in particular situations could be to determine reasonable goals for the development of shared or distributed knowledge and practices across a faculty, in the process leveraging different strengths, interests, and needs. Fifth, the participants' perspectives on what is missing from the TETCs can inform potential changes or additions to the existing set of 12 competencies. Finally, the different contexts of teacher education, particularly regarding content area and preparation for different grade levels, suggest that teacher educators are likely to need different kinds and levels of support to develop their technology competencies.

7. Conclusion

While other sectors of education have had defined standards for digital technology knowledge, skills, and dispositions for students, teachers, and administrators, the teacher educator field has, until recently, not had such guidelines. The TETCs have provided a helpful starting point for advancing the teacher education field towards more effective use of educational technology by teacher educators and those with whom they work. By providing the perspectives of a large, international sample of teacher educators regarding the TETCs, this research can further advance the important conversation around the role(s) of digital technologies in teacher education. Our findings suggest that conversation could benefit from consideration of additional competencies not present in the existing TETCs and the factors beyond individual teacher educators' technology competencies that influence their preparation of prospective teachers.

Author note

A repository with the statistical code used for the analyses in this study, as well as output, is made available for the peer-review process here: http://bit.ly/osftetcs.

Declaration of competing interest

The authors declare they have no competing interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tate.2020.103124.

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