Validation of a Technology Proficiency Survey for Educators

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Abstract: This study included the development of a valid and reliable instrument to assess educator proficiency based on standards for educators. Factor analysis was used to provide one form of construct validity revealing three highly reliable subscales. Criterion-related validity was shown by measuring changes in pre-post uses, contrasts by content delivery mechanism and by alignment with established related measures. The TPSE appears to be a valid and reliable survey instrument useful for content that is aligned with the ISTE 2017 standards.

Keywords: measurement; proficiency; assessment; technology standards; preservice teachers

Introduction

Preparing future teachers to integrate technology in a thoughtful, reflective way is important in order to impact learning via technology. While many are advocating to no longer have a stand-alone technology integration course, it can be a valuable asset to a teacher preparation program if the course is approached in a contextual, content-focused manner that involves pedagogical reasoning for the use of technology in instruction (Loughran, 2019). Aligning a technology integration course with valued educational technology standards that also focus on higher level ideas rather than technology use skills can be one way to ensure the course is of value to future teachers. This paper addresses the development of a survey instrument based on the ISTE standards (ISTE, 2017) that was one of several assessment tools used to measure growth of technology integration during the semester-long technology integration course.

Literature Review

The preparation of teachers has been recognized as a critical ingredient for the integration of technology into the classroom (Dawson, Dana, Wolkenhauer, & Krell, 2013; Tondeur, van Braak, Sang, Voogt, Fisser & Ottenbreit-Leftwich, 2012). Preparing teachers to use technology in an effective way in the classroom is critical to the impact they will have in the classroom. Technology integration proficiency is a multifaceted attribute of an individual teacher that involves technology knowledge and skills, confidence in the knowledge and skills, and pedagogical expertise, merged together with content knowledge in a discipline.

Researchers have investigated the factors affecting teachers' use of digital technology in the classroom and concluded that preservice training in technology led to better skilled teachers with the right attitudes to promote the use of technology in the curriculum (Spiteri & Rundgren, 2018). Introducing and modeling tools and strategies, having students practice these skills and then reflecting on the use technology integration can be important components in preservice teacher education. Having preservice students create instruction that includes technology integration builds confidence.

Self-efficacy has been defined as confidence in one's competence (Christensen & Knezek, 2017). Self-efficacy is a factor that influences the effectiveness of teaching with technology (Hoy, Hoy & Davis, 2009). According to Bandura (1993), self-efficacy is a good predictor of behavior. Oliver and Shapiro (1993) found teachers' self-efficacy beliefs to be indicators of success for technology integration. Teachers' beliefs about technology can impact the integration of technology into their teaching practices (Compeau, Higgins, & Huff, 1999; Ertmer, 1999, 2005).

This survey instrument was developed to assess the impact of content of a preservice course that follows the ISTE standards for educators. In order to determine whether the survey is reliable and valid, several analyses were conducted using the available student data. Research questions that guided this study are listed below.

Research Questions

1. To what extent does the TPSE instrument form a reliable and valid measure of recommended teacher competencies?

2. What constructs are measured by the instrument based on 22 items developed to address the ISTE competencies?
3. To what extent do TPSE Survey total scale and subscales distinguish among relevant course delivery mechanisms?
4. To what extent do the TPSE total scale and subscales relate to other educator technology proficiency measures?

Methods

Study Participants

Analyses of the Technology Proficiency Survey for Educators (TPSE) were based on the completed posttest surveys of 83 participants consisting of preservice students in a course focused on integrating technology into their future classrooms. More complete data that allowed for validity of the TPSE survey included a subset (n=58) of the 83 participants who had pre and post test data for all the additional surveys.

The educational technology course is a required course for all preservice students at a large university in the southwest part of Texas. This course was offered online or blended and was taught through a learning management system and video conferencing system. The content focused on how to integrate technology into the classroom to impact learning. Four assignments and weekly activities culminated in a final electronic portfolio that included a unit plan with technology integrated lessons as well as a reflection on their learning about using technology in the classroom during the semester. Many of the tools and strategies introduced in the course were included in the unit plans. Students used tools such as *Adobe Spark* or *iMovie* for digital storytelling, *BrainPop* to teach digital citizenship, *Thinglink* to create non-linear multi-media topic-based activities, *Whyville* for introducing science topics with games and simulations, and augmented and virtual reality for visualization of content.

At the beginning of the semester, students explored and selected a topic and grade level in which they would focus the development of a unit plan that included activities that integrated technology tools. They were also required to include an essential question that would allow them to focus at a higher level of thinking toward the creation of the unit plans. Students created a unit plan that included three weeks of lessons focused on the topic they selected. In addition to the essential question, students included unit questions, content and technology standards, objectives, activities, differentiated instruction and assessment tools. During the exploration of technology tools, students submitted sample activities and how they might use the tools for their unit. For each activity in the unit that included technology, the students were required to include the PIC-RAT (Kimmons, Graham, & West, 2020) classification and reflect on the reasoning behind their choices. Feedback was provided on each activity by the instructor.

The course materials and resources were all available online through the learning management system. However, it was not clear what technology tools each of the students had on their personal devices so the instructor identified apps and tools that were readily accessible to all students and they were given choices of tools to use. The instructor selected tools that were widely available for free even if it was only a trial or educational version of the tool. While it was more challenging for the instructor, it was more of a reality of what they would likely encounter as classroom teachers. While online tutorials were often linked as aids in using different tools, classroom meetings did not include the teaching of skills for individual software or technology tools.

The data set used for the pre-post measure analyses included three different semesters. Two of the semesters followed a blended method of instruction with online information available online in the LMS but with five class meetings face to face throughout the semester. One semester the students were exclusively online but met via videoconferencing each week. The demographics of the subjects 79% females and 21% males. 38% plan to teach preK-2, 17% plan to teach grades 3-5, 12% plan to teach grades 6-8, 29% plan to teach grades 9-12 and 3% plan to teach something other than preK-12. The average age reported was 29 with a range of 19 to 61. The number of students in the blended course included 34 (58.6%) and the number of students in the online course was 24 (41.4%).

Instrumentation

In 2018, the author developed a Technology Proficiency Survey for Educators (TPSE) survey based on the ISTE standards for educators (2017) to use as a pre-post assessment measure for a preservice course focused on technology integration in the classroom. Sixteen of the items were created by the author based on the seven categories of the ISTE standards for educators. The seven categories were: Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst. Six of the items were from previous work by the author on instruments used for measuring teacher technology efficacy (Christensen & Knezek, 2017). Each of the items follows the stem, "I feel confident I could…". The participants were asked to respond to their level of agreement to each of the 22 items from a level of 1 = Strongly Disagree to 5 = Strongly Agree. The individual items are listed in Table 1.

Table 1. Twenty-Two Items from the Technology Proficiency Survey for Educators (TPSE)

	I feel confident I could….
1.	…use technology to improve my teaching practices.
2.	…participate in local and global learning networks to pursue professional interests.
3.	…use educational technology research to inform and improve my classroom practices.
4.	…lead and support other educators in the integration of technology in the classroom.
5.	…use technology to meet the diverse needs of students in my classroom.
6.	…model and promote safe, legal and ethical practices with digital tools.
7.	…model and promote the management of personal data and digital identity.
8.	…provide students with the opportunity to make positive and responsible contributions in online communities.
9.	…use technology to create authentic learning experiences.
10.	…use technology to communicate appropriately with students, parents and colleagues to support and enhance student learning.
11.	…use technology to collaborate with teachers or students who are distant from my classroom.
12.	…use technology to create, adapt and personalize learning for students in my classroom.
13.	…create digital learning environments that engage and support student learning.
14.	…create learning opportunities in which students use computational thinking to innovate and solve problems.
15.	…model and nurture creativity in communicating knowledge to students and peers.
16.	…facilitate learning in which students take ownership of their learning goals and outcomes.
17.	…use digital tools for assessment to inform instruction.
18.	…use technology to design and implement a variety of assessments to accommodate learner needs.
19.	…use technology to capture student learning in a variety of ways.
20.	…use social media tools for instruction in the classroom. (ex. Facebook, Twitter, etc.)
21.	…create a wiki or blog to have my students collaborate.
22.	…teach in a one-to-one environment in which the students have their own devices.

In addition to the TPSE items, the participants completed the Stages of Adoption of Technology (Christensen, 2002), the SQD (Tondeur, vanBraak, Siddiq, & Scherer, 2016), the TPACK core scale (Fisser, Voogt, Van Braak, & Tondeur, 2013) and demographic items. These additional surveys will be used for the validation of the TPSE survey.

The Stages of Adoption of Technology survey (Christensen, 2002) is a self-assessment of a teacher's level of adoption of technology based on Roger's (1983) Diffusion of Innovations theory and adapted from a survey regarding email (Russell, 1995). There are six possible stages in which educators rate themselves: Stage 1 (*Awareness*), Stage 2 (*Learning the process*), Stage 3 (*Understanding and application of the process*), Stage 4 (*Familiarity and confidence*), Stage 5 (*Adaptation to other contexts*), and Stage 6 (*Creative application to new contexts*).

The SQD questionnaire items were adapted from the SQD-Model (Synthesis of Qualitative Evidence) (Tondeur et al., 2016). These items were developed based on assessing effective strategies needed to prepare future teachers. The SQD scale consisted of six parts related to what students reported occurred during their pre-service program training. The six areas of the SQD include *Role Model*, *Reflection*, *Instructional Design*, *Collaboration*, *Authentic Experiences and Feedback*. The Cronbach's alpha for each of the areas has been shown to be between .90 and .96 and considered to be very good (Christensen & Knezek, 2019) according to DeVellis (DeVellis, 1991). *Role Model* is a measure of seeing examples of technology use for educational settings that may have inspired the individual to use these tools for themselves. *Reflection* includes the opportunity to discuss experiences creating and/or using technology for classroom learning. *Instructional Design* reflected the amount of help the future teacher received in designing technology-rich learning materials. *Collaboration* items related to sharing technology information as well as working with others to develop technology-enriched experiences. *Feedback* items were related to the amount of feedback students received regarding technology competencies and use. *Authentic Experiences* items were used to measure the amount of opportunity preservice students received in testing their technology activities in educational settings and trying out their technology activities in authentic settings.

Another measure of technology integration completed by participants was the Technological, Pedagogical and Content Knowledge (TPACK) Core scale. This scale is one part of the TPACK survey (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009) that appears to be most related to the integration of technology and has been used to measure the core of the technology integration component of TPACK (Fisser et al., 2013).

Results: Performance of the Instrument

Results from this study are focused on testing the psychometric properties of the Technology Proficiency Survey for Educators (TPSE) instrument. The three forms of validity most often deemed important for psychometric instruments are content, construct, and criterion-related validity (DeVellis, 2012). The TPSE is believed to have good face validity due to development aligned with well-established standards upon which the course content was created. Construct validity is commonly verified through factor analysis and is described in this section. Content validity can be established by showing that the instrument includes the range of items to measure what is in the realm of the entire topic or course. Criterion-related validity most commonly comes in two forms: a) demonstrating alignment of the new instrument with an established index or scale that is known in the profession to be relevant to the focus of the newly created scale(s), and/or b) showing that the new scale(s) are capable of separating groups that might be expected to differ on the constructs assessed by the new instrument scale(s).

In addition to validity measures, internal consistency reliabilities for the total survey instrument as well as three individual subscales will be examined in this section.

Construct Validity through Factor Analysis

Exploratory factor analysis (principal components, varimax rotation) was conducted with the data from the 83 posttest respondents. Using the default criterion of Eigenvalue > 1.0 for extraction of factors, the factor analysis procedure extracted three factors accounting for 68% of the common variance in the data (see Table 2). The factor loadings for each of the subscales are shown in Table 3. With the exception of one item (item 21), the factor loadings were all above the .5 cutoff criteria (.5 x .5 = 25% of the variance of an item in common with the construct) that is often used in exploratory factor analysis. After reading the items in each of the factors, the structure seemed appropriate. Factor 1 items are related to modeling and facilitate learning with technology. The 2nd factor items focus on improving instruction with technology and the 3rd factor items are related to collaborating, communicating, and engaging with technology.

Table 2. Total Variance Explained for Eigenvalues Greater Than One

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.437	56.532	56.532	12.437	56.532	56.532	5.568	25.307	25.307
2	1.350	6.138	62.670	1.350	6.138	62.670	5.182	23.553	48.860
3	1.093	4.969	67.639	1.093	4.969	67.639	4.131	18.779	67.639
4	.994	4.517	72.156						
5	.882	4.011	76.167						
6	.757	3.441	79.608						
7	.632	2.871	82.479						
8	.550	2.498	84.977						
9	.506	2.298	87.275						
10	.418	1.898	89.173						
11	.381	1.730	90.903						
12	.343	1.559	92.462						
13	.293	1.331	93.793						
14	.263	1.196	94.988						
15	.220	.999	95.987						
16	.201	.913	96.900						
17	.178	.808	97.709						

18	.148	.674	98.383						
19	.111	.506	98.889						
20	.093	.422	99.312						
21	.083	.379	99.690						
22	.068	.310	100.000						

Table 3. Factor Loading for the Three Subscales

	Component		
	1	2	3
TTA18	.769	.228	.273
TTA14	.750	.366	.265
TTA15	.703	.539	.159
TTA17	.666	.172	.336
TTA1	.634	.144	.516
TTA9	.584	.458	.372
TA12	.573	.562	.271
TTA5	.562	.455	.406
TTA19	.536	.509	.427
TTA7	.518	.465	.100
TTA10	.236	.817	.160
TTA11	.173	.775	.258
TTA8	.519	.682	.127
TTA13	.483	.603	.440
TTA6	.521	.574	.182
TTA16	.384	.539	.391
TTA21	-.028	.461	.722
TTA4	.418	.238	.714
TTA20	.215	.034	.654
TTA2	.410	.116	.645
TTA22	.216	.414	.598
TTA3	.302	.524	.541

Note: Rotation converged in 14 iterations.

Reliability

Internal consistency reliability (Cronbach's Alpha) was calculated using post test data only to estimate the consistency of the scale produced from the survey items. Cronbach's Alpha was found to be .96, with none of the items indicating weakness to the point that removing the item would strengthen the scale. This reliability is very good according to guidelines by DeVellis (2012). The Cronbach's Alpha for each of the three subscales is shown in Table 4. Only one of the subscales included a higher internal consistency reliability with an item removed. The Cronbach's Alpha for Subscale 3 would have been .86 with item 20 removed. Internal reliability estimates for the three constructs ranged from .84 to .94, which is in the "respectable" to "excellent" range according to DeVellis (2012).

Table 4. Reliability for Three Subscales

	Alpha	No. Items	N
Subscale 1: Design, create and model learning with technology	.94	10	83
Subscale 2: Communicate and collaborate using technology	.91	6	83
Subscale 3: Extending learning beyond the classroom with technology	.84	6	83
Total Scale	.96	22	83

Content Validity: Measuring the Range of Criteria for the Course

The course content was developed to follow ISTE standards as was the instrument developed following the ISTE technology standards for educators. The author of the course recognizes that the three constructs/subscales represent the overall range of the course as is shown in the pre-post means. The growth reflects what was learned in the course and thus represents content validity for the survey instrument. Regarding the Technology Proficiency Survey for Educators (TPSE) subscales, significant ($p < .05$) changes pre to post were found for all three subscales as well as the total instrument. As shown in Table 5, the magnitude of the pre to post gain effect size ranged from .58 to .68, which is moderately large according to guidelines by Cohen (1988), beyond the effect size = .3 criteria for an effect that is normally considered educationally meaningful (Bialo & Sivin-Kachala, 1996), and well within the zone of desired effects according to modern psychometric standards (Lenhard & Lenhard, 2016).

Table 5. Pre-Post Means for the Three Subscales and Whole Survey

Subscale		N	Mean	Std. Dev.	Sig.	Cohen's d ES
TPSE Subscale1	Pre	94	4.21	.70		
Design, create and model learning with technology	Post	83	4.58	.52		
	Total	177	4.38	.65	.000	0.60
TPSE Subscale2	Pre	94	4.35	.65		
Communicate and collaborate using technology	Post	83	4.68	.45		
	Total	177	4.50	.59	.000	0.58
TPSE Subscale 3	Pre	94	3.84	.76		
Extending learning beyond the classroom with	Post	83	4.32	.66		
technology	Total	177	4.06	.75	.000	0.67
TPSE Total	Pre	94	4.14	.66		
	Post	83	4.54	.50		
	Total	177	4.33	.62	.000	0.68

Criterion-Related Validity: Contrasts by Content Delivery Mechanism

In two semesters of the course it was offered as blended and one semester was completely online but with meetings held via videoconferencing tools. An interesting contrast is shown in Tables 6 and 7 regarding the semester pre-post differences between the blended and online delivery mechanisms for the course. At pretest time, there were significant differences ($p<.05$) in two of the three TPSE subscales and in the total survey with online students being significantly higher in their measured dispositions than students in the blended course format. However, by the end of the semester, there were no significant differences ($p<.05$) between the two groups on any of the TPSE measures and in fact, very little differences in means between the two groups at post test time. These findings are an indication that the survey instrument measures what is covered in the course and no matter where students begin they end in a similar place due to experiencing the same content no matter what the delivery mechanism.

Table 6. Pretest by Blended versus Online

		N	Mean	Std. Deviation	Sig.
TPSE Subscale1 Design, create and model learning with technology	Blended	34	4.07	.66	
	Online	24	4.45	.52	
	Total	58	4.23	.63	.022
TPSE Subscale2 Communicate and collaborate using technology	Blended	34	4.08	.58	
	Online	24	4.35	.64	
	Total	58	4.19	.61	.111
TPSE Subscale 3 Extending learning beyond the classroom with technology	Blended	34	3.67	.69	
	Online	24	4.12	.66	
	Total	58	3.86	.71	.017
TPSE All	Blended	34	3.98	.60	
	Online	24	4.34	.55	
	Total	58	4.13	.60	.025

Table 7. Post test by Blended versus Online

		N	Mean	Std. Deviation	Sig.
TPSE Subscale1 Design, create and model learning with technology	Blended	28	4.56	.48	
	Online	26	4.60	.54	
	Total	54	4.58	.51	.800
TPSE Subscale2 Communicate and collaborate using technology	Blended	28	4.63	.44	
	Online	26	4.61	.51	
	Total	54	4.62	.47	.893
TPSE Subscale 3 Extending learning beyond the classroom with technology	Blended	28	4.33	.55	
	Online	26	4.32	.65	
	Total	54	4.33	.60	.973
TPSE All	Blended	28	4.53	.45	
	Online	26	4.54	.52	
	Total	54	4.53	.48	.944

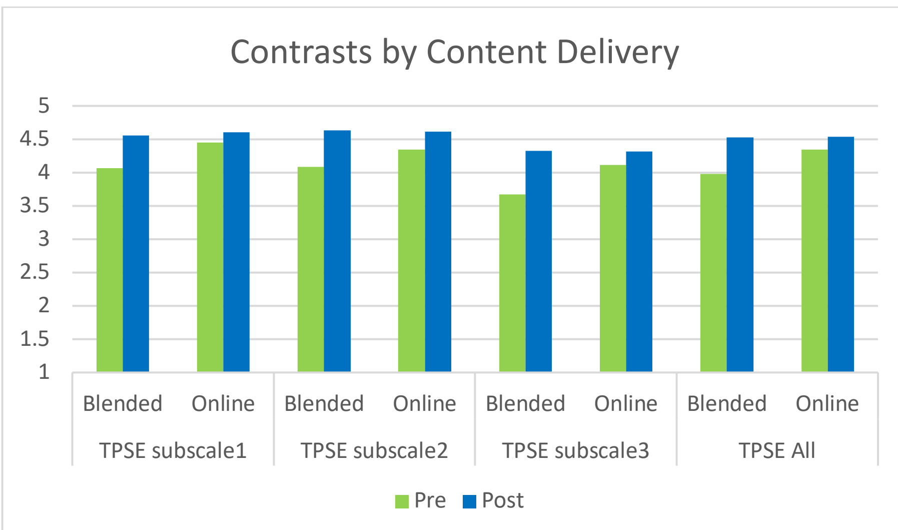

Figure 1. Pre-post measures comparing types of content delivery method.

Criterion-Related Validity: Alignment with Established Measures

Criterion validity evaluates how closely the results of your test correspond to the results of a different measure. To evaluate criterion validity, the correlation between the TPSE and the results of other valid technology integration measures was completed. These prior measures included *TPACK Core* (Fisser et al., 2013), the six *SQD sub*scales (Tondeur et al., 2012) and *Stages of Adoption of Technology* (Christensen, 2002). As shown in Tables 8 and 9, there is a significant correlation between the three subscales of the TPSE and each of these technology integration measures. The correlations provide a good indication that the TPSE is measuring what it intends to measure as it relates to more well-established measures.

Correlation coefficients between TPACK Core and Subscale 1 and 2 are considered to be strongly positive (>.7) while the correlation between TPACK Core and Subscale 3 is considered to be weak (Moore, Notz, & Flinger, 2013). The correlation between most of the six SQD subscales and the TPSE subscales appears to be in the range of moderately positive (Moore et al., 2013) and especially in the areas of role model, designing instruction, authentic experiences and feedback. The correlations between the TPSE subscales and Stages of Adoption of Technology were significant but considered to be weak (Moore et al., 2013).

Table 8. Correlation of TPSE Subscales with TPACK Core

		TPACK Core
TPSE Subscale1	Pearson Correlation	.744**
Design, create and model learning with technology	Sig. (2-tailed)	.000
	N	39
TPSE Subscale2	Pearson Correlation	.710**
Communicate and collaborate using technology	Sig. (2-tailed)	.000
	N	39
TPSE Subscale 3	Pearson Correlation	.467**
Extending learning beyond the classroom with	Sig. (2-tailed)	.003
technology	N	39
TPSE Total	Pearson Correlation	.711**
	Sig. (2-tailed)	.000
	N	39

Table 9. Correlation of TPSE Subscales with Six SQD Subscales

		Role	Reflection	Design	Collab	Auth Exp	Feedback
TPSE Subscale1 Design, create and model learning with technology	Pearson Correlation	.603**	.517**	.632**	.533**	.586**	.631**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	83	83	83	83	83	83
TPSE Subscale2 Communicate and collaborate using technology	Pearson Correlation	.500**	.495**	.552**	.446**	.497**	.510**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	83	83	83	83	83	83
TPSE Subscale 3 Extending learning beyond the classroom with technology	Pearson Correlation	.557**	.471**	.639**	.532**	.588**	.576**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	83	83	83	83	83	83
TPSE Total	Pearson Correlation	.608**	.536**	.665**	.553**	.611**	.631**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	83	83	83	83	83	83

Summary

Factor analysis was used to provide one form of construct validity. The factor analysis results revealed that the survey formed three distinct factors that were found to have high internal reliability estimates that ranged from .84 to .94, which is in the "respectable" to "excellent" range according to DeVellis, 2012. Upon reading the items formed within each of the factors, the author deemed they were combined in a meaningful way which is considered face validity Content validity was further shown in the alignment of the course with the instrument that were both based on a well-established set of standards.

Construct validity is the ability of an instrument to detect changes after an intervention or differences among different groups. The pre-post means of the course reflect what was learned in the course based on the standards. The subscales were also able to differentiate between different groups of students and in this case by the type of course content delivery they experienced. Criterion validity evaluates how closely the results of your test correspond to the results of a different test. The analyses showed a significant positive correlation between the TPSE subscales and other well-established measures of similar concepts.

Implications

Preparing future teachers to integrate technology in a thoughtful, reflective way is important in order to impact teaching and learning via technology. Aligning a technology integration course with valued educational technology standards that also focus on higher level ideas rather than technology use skills can be one way to ensure the course is of value to future teachers. Creating a valid and reliable instrument for assessing that the concepts and ideas taught in the course is an important tool for feedback and course correction. The instrument presented in this paper appears to have good psychometric abilities to measure indices related to the integration of technology into instruction.

The instrument could be used for other teacher preparation courses that include technology integration goals and objectives within the course. The survey contains only 22 items and takes very little time to complete yet may yield clear indicators of met course objectives. Inservice education providers may also find this to be a useful survey instrument as the ISTE standards were intended for all K-12 educators. In summary, the TPSE appears to be a valid and reliable survey instrument useful for course content that is aligned with the ISTE 2017 standards.

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