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Development and validation of the educational technologist competencies survey (ETCS): knowledge, skills, and abilities

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Abstract The purpose of this research was to identify the competencies of educational technologists by surveying the professionals within the field. The Educational Technology Competency Survey (ETCS) developed in this research was based on a conceptual framework that emphases the definition of educational technology and associated knowledge, skill, and ability statements (KSAs). Using the conceptual framework, the study was executed in four phases: (1) an extant review of relevant literature related to competencies of educational technology professionals, (2) job announcement analysis of 400 postings from five relevant databases, (3) extraction and merging of the KSA statements from the job announcements and relevant literature, (4) administration of the survey on a wide-variety of educational technology professionals ($N = 219$). One hundred seventy-six KSA competencies were derived from the process and organized into KSA statements. The data was analyzed using descriptive statistics, exploratory factor analysis, internal consistency reliability, and multivariate analysis of variance. The findings demonstrate key competencies such as instructional design, project management, learning theories, working in teams with diverse stakeholders, and twenty-first-century proficiencies. Discussion and recommendations for future research and practice are provided. The ETCS was found to be a valid and reliable measurement system for these data.

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Introduction

What knowledge, skills, and abilities (or competencies) must one possess to be an effective educational technologist? This question has been addressed to some extent by a number of researchers and practitioners from a variety of educational technology contexts (e.g., Brill et al. 2006; Daniels et al. 2012; Kenny et al. 2008; Liu et al. 2002; Lowenthal et al. 2010; Ritzhaupt and Martin 2014; Ritzhaupt et al. 2010; Sugar et al. 2012; Sumuer et al. 2006; Tennyson 2001; Williams van Rooij 2013; Wakefield et al. 2012). Prior research suggests that educational technologists must be abreast in learning theories (Ritzhaupt et al. 2010; Ritzhaupt and Martin 2014; Tennyson 2001), instructional design models and processes (Kang and Ritzhaupt 2015; Ritzhaupt et al. 2010; Ritzhaupt and Martin 2014; Tennyson 2001), project management techniques (Brill et al. 2006; Ritzhaupt and Kumar 2015; Ritzhaupt and Martin 2014; Williams van Rooij 2013), and must be able to effectively use a wide-variety of software packages ranging from office productivity tools to authoring tools to comprehensive Learning Management Systems (Lowenthal et al. 2010; Ritzhaupt et al. 2010; Ritzhaupt and Martin 2014; Ritzhaupt and Kumar 2015; Sugar et al. 2012).

The research question posed has been addressed using a wide variety of methodological techniques to draw inferences about the phenomena, including job announcement analysis (Kang and Ritzhaupt 2015; Moallem 1995; Ritzhaupt et al. 2010; Sugar et al. 2012), Delphi technique (Daniels et al. 2012; Brill et al. 2006), interviews (Liu et al. 2002; Ritzhaupt and Kumar 2015), and survey research (Ritzhaupt and Martin 2014; Sugar et al. 2009). While methodological variety is important, the problem is that we do not have a valid and reliable mechanism to measure the beliefs of professionals within the field of educational technology about the importance of competencies. That is, we do not fully understand what our community values in terms of competencies for educational technology professionals, nor do we have a framework to explain these competencies in a meaningful context. Thus, this paper provides a review of the competencies of educational technology professionals and provides a conceptual framework to explain this context. Then, this paper provides the validity and reliability evidence of a tool designed to measure the importance of competencies from educational technology professionals.

Conceptual framework

Following the work of Ritzhaupt and Martin (2014), our conceptual framework incorporates a widely-accepted definition of educational technology (Januszewski and Molenda 2007) and connects the definition to knowledge, skill, and ability (KSA) statements (Wang et al. 2005). KSA statements were adopted because they are used to create competencies for licensure and certification exams (Wang et al. 2005). In our conceptual framework, KSA represents the processes and resources needed by educational technologists to be effective in their professional roles. The definition of educational technology highlights three bodies of knowledge for characterizing the work of professionals in educational technology: create, use, and manage. Specifically, the definition is

> “Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources” (Januszewski and Molenda 2007, p. 1).

Figure 1 illustrates the conceptual framework revised from Ritzhaupt and Martin (2014). Figure 1 illustrates the three actionable terms: create, use, and manage as circles. Each circle represents a separate body of knowledge in educational technology. A triangle to envision the KSA statements within the circles as the processes and resources is also visualized. We use a triangle to show that the “statements can be thought of as overlapping in which skills rest upon knowledge, and abilities rest upon skills” (Ritzhaupt and Martin 2014, p. 14).We believe that competencies are generally measurable or observable KSAs critical to successful job performance. The term educational technologist has been defined in this study to include wide array of job titles ranging from instructional designers to curriculum designers and more.

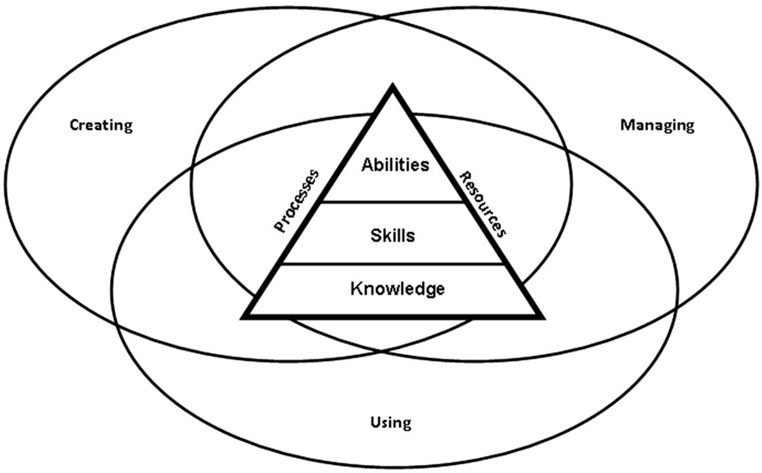

Fig. 1 Knowledge, skill, and ability statements as core competencies in educational technology. (Reproduced with permission from Ritzhaupt and Martin 2014)

Educational technologist

The term “educational technologist” is used to describe the many professionals that practice in the field of educational technology. This term does not only include instructional designer and is also often interchangeably used with the term instructional technologists. Additionally, this term includes job titles like learning designer, instructional developer, instructional technology specialist, e-Learning developer, performance improvement consultant, chief learning officer, director of training, training and development manager, educational project manager, and several more professional roles in the field. Indeed, our professional associations play an important role in cultivating our field and professional identity.

Tennyson (2001) defines an instructional technologist as “a person is employing the instructional design process to solve learning and performance problems and needs in a technology-based learning environments” (p. 356) and also lists three attributes of core knowledge competencies required for instructional technologists, (1) educational foundations, (2) instructional systems design methodology and (3) instructional design process experience. In addition, Sugar (2005) reports that instructional technologists should graduate from instructional design or instructional technology graduate programs. Izmirli and Kurt (2009) conclude their study with a broader definition for instructional technologists as “technology experts who are competent in human relationships, develop the school-family relationships, know basic teaching–learning theories well, and who know how to integrate technology into the learning environment” (p. 1001).

Educational technology competencies

The competencies required to be an instructional or educational technologist may differ across companies, schools, and cultures (Izmirli and Kurt 2009). A competency is “a knowledge, skill or ability that enables one to effectively perform the activities of a given occupation or function to the standards expected in employment” (Richey et al. 2001, p. 26). Spector and de la Teja (2001) define competence as the “state of being well-qualified to perform an activity, task or job function” and competency as “the way that a state of competence can be demonstrated to the relevant community” (p. 2). Alternatively, the International Board of Standards for Training, Performance and Instruction (IBSTPI) defines a competency as “an integrated set of skills, knowledge, and attitudes that enables one to effectively perform the activities of a given occupation or function to the standards expected” (IBSTPI 2017, p. 1).

Sampson and Fytros (2008) acknowledge that “competence-based approaches are often adopted as the key paradigm in both formal or informal education and training program” (p. 155). Thus, competencies are vital to the success of an educational technology program as well as job seekers looking to fill a specific toolkit. This creates an environment where competencies need to be reexamined as technology consistently changes business culture. As a result, several professional organizations have attempted to define competencies for our professionals including the International Society for Technology in Education (ISTE), IBSTPI, the Association for Educational and Communications Technology (AECT), International Society for Performance Improvement (ISPI), and the Association for Talent Development (ATD). Developing competencies is a continuous lifecycle that has been described by the following steps (1) identify need for competency model of a specific field/position/job, (2) develop a competence model, (3) gap analysis of existing and required competencies, (4) strategies to minimize gaps, and (5) continuous assessment to determine and maintain return on investment (adapted from Sampson and Fytros 2008; Sinnott et al. 2002).

Professional organizations and competencies

As noted, some professional organizations have identified competencies for educational technologists. In this section, competencies from some of the leading educational technology professional organizations are reviewed, including ISTE, IBSTPI, AECT, ISPI, and ATD.

The IBSTPI competency model consists of three main components–domains, competencies, and more specific performance statements. The IBSTPI considers competencies as the core component of the IBSTPI® model and these are short statements, each one providing a general description of a complex effort. Each competency is supported by a list of performance statements which provide a fuller description of how the competency is demonstrated. The IBSTPI has 22 newly updated IBSTPI® instructional design competencies in the revised 2012 edition. These competencies are clustered into five domains including, professional foundations, planning and analysis, design and development, evaluation and implementation, and management; and are supported by 105 performance statements (IBSTPI 2017). The IBSTPI also has competencies for evaluators, instructors, online learners, and training managers.

The IBSTPI followed a rigorous process to develop and validate competencies (Klein and Richey 2005). The process of competency development involves identifying the knowledge, skills, attitudes, capabilities, and tasks associated with job roles such as an instructional designer (Spector et al. 2006). Richey et al. (2001) identified knowledge, skills, attitudes, and tasks associated with a particular job role of instructional designer as analyst/evaluator, online learner, instructor, and training manager. Once a job role was defined then current practices and existing standards were identified to facilitate competency development. Additionally, ethics and values are used to evaluate job-related behaviors. Finally, the evolving nature and the future of the job roles were articulated. Current practice, existing standards, ethics, values, and a vision of the future collectively provide the major input into the identification and validation of the knowledge, skills and attitudes which are critical to effective performance in a particular job role (Spector et al. 2006). The IBSTPI competency development process included five major phases: (1) identification and review of foundational research, (2) competency drafting, (3) competency validation, (4) revision and rewriting and, (5) publication and dissemination (Spector et al. 2006). The formal competency validation process included survey research to establish the extent to which each competency and performance statement is clearly stated and representative of a critical job-related function, task or activity. These instruments were administered to a several hundred practitioners and scholars in diverse geographical locations and work settings.

ISTE develops standards for students, educators, administrators, computer science educators, and coaches involved in the appropriate uses of educational technology in both formal and informal educational settings (ISTE 2017). These standards are refreshed using an evidenced-based process about each decade. For example, the current student standards are in their third version and were recently released to the larger community in 2016. The new student and educators standards provide attributes such as *Digital Citizen* or *Creative Communicator*, and a list of supporting indicators like "students demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property" (ISTE 2017). These standards have been widely adopted both nationally and internationally (ISTE 2017), and have even been used to develop measurement tools like surveys or performance assessments to measure the outcomes (Huggins et al. 2014).

In the 2012 version, AECT identified five different standards in the areas of content knowledge (five indicators), content pedagogy (five indicators), learning environments (six indicators), professional knowledge and skills (five indicators), and research (four indicators). While the standards are broad performance statements, the indicators are more specific statements in the areas of creating, using, assessing/evaluating, managing, ethics and diversity. There were totally 25 indicators within the five standards proposed by AECT and these standards are based on the most recent definition of the field (Januszewski and Molenda 2007). Many educational technology academic program adopt these standards for their curriculum.

ATD (2017) includes 10 areas of expertise (AOE) based on knowledge, skills and abilities required for training and development professional in their current version of the model. The 10 AOEs are designed so that one can choose where to focus. So that a developer might only need to focus on two to three versus a designer or project manager which may need to focus on others. Thus, there is no one model fits all for a specific role. ATD has also developed a Competency Model for Learning and Performance, which identifies the roles, areas of expertise, and foundational competencies for profession. The ATD model was used to develop the *Certified Professional in Learning and Performance* (CPLP) certification offered by ATD to recognize talent development professionals. Finally, ISPI has developed standards for Certified Performance Technologist (CPT) designation, which is based on a set of ten broad standards competent practitioners follow in the practice of human performance technology. The CPT standards are accompanied with rich descriptions and examples. As shown in this section, many professional organizations are in the business of documenting the competencies and standards of the professionals working in our field.

Purpose

Izmirli and Kurt (2009) have suggested that researchers and practitioners come together to develop competencies for the field. Therefore, the purpose of this research is to use the KSA and educational technology framework described above to document the competencies of educational technologists based on the perceptions of professionals working in the field of educational technology using a multi-phased approach. This multi-phased approach is detailed in the method section. The overarching question guiding this research is: What knowledge, skills, and abilities (or competencies) must one possess to be an effective educational technologist?

Method

Instrument design and development

Our instrument design and development was executed in four distinct phases, following the recommendations of Ritzhaupt et al. (2010) and Ritzhaupt and Martin (2014). This process is visualized in Fig. 2. First, we conducted an extant review of literature related to the competencies of educational technology professionals (e.g., Ritzhaupt et al. 2010; Sugar et al. 2012; Daniels et al. 2012; Tennyson 2001; Brill et al. 2006; Williams van Rooij 2013; Wakefield et al. 2012). Second, we collected 400 job announcements in the field of educational technology published over a 5 month period (August 2013–December 2013). Third, we examined the job announcements themselves using an emergent theme content analysis in which the themes (or competencies) emerged from the job postings themselves (Tashakkori and Teddlie 1998). These competencies were then merged with the competencies identified from the review of the literature (Kang and Ritzhaupt 2015). Fourth, we created a comprehensive survey of 176 key competency areas organized into KSA statements and released the survey on a large sample of educational technology professionals to validate the structure of the instrument and learn professional perceptions about the various competencies in the field of educational technology.

The draft instrument was reviewed by three professionals within the field educational technology for clarity and intent. Statements were revised based on the feedback collected. The instruments were assigned the following response scale for

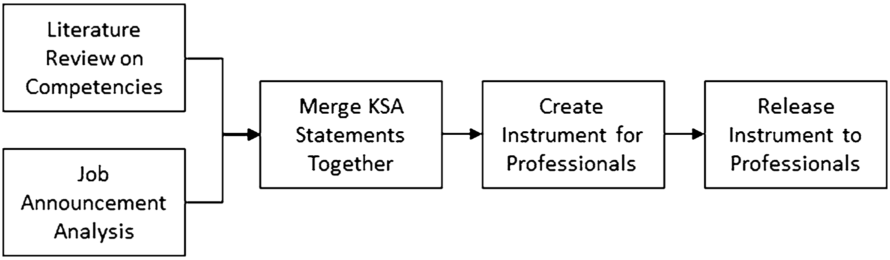

Fig. 2 Instrument development procedures

the KSA statements: not important at all (1); important to a small extent (2); to some extent (3); to a moderate extent (4); and to a great extent (5). This response scale was adopted to gauge the relative importance of a competency from an educational technology professional's perspective. The instructions for participants read "Please indicate the importance of the following (knowledge/skill/ability) statements in creating, using, and managing learning resources and processes." The final instrument included a background section that collected relevant demographic information and 176 competency items in one of the three domains (i.e., knowledge, skills, and abilities). The given name of the survey was the Educational Technologist Competency Survey (ETCS).

Participants

A total of $N = 337$ opened the survey and responded to the consent page. However, many participants did not complete the full instrument. A final sample of $N = 219$ or 65% educational technology professionals completed at least the first two sections of the final instrument and were retained in the sample for further analysis. As can be gleaned in Table 1, participants represented a wide range of professional backgrounds. Forty-seven percent of the sample was male, and the remaining female. We have representation in our sample from every state within the United States ($n = 200$), and also from outside the United States ($n = 19$). Eighty percent of the same identified as White/Caucasian, and the participants' income levels normally distributed with the highest proportion earning \$50,001–\$75,000 ($n = 77$) per year. More than 70% of the sample participants earned a master's or doctoral degree. The age range of the participants normally distributed with more than 50% of the sample between the ages of 36 and 55. Eighty-eight percent of the participants identified as professionals working in a wide range of sized organizations. The participants averaged 13.51 ($SD = 9.64$) years of experience in the field.

Procedures for data collection

The ETCS was released to a wide audience via the ITFORUM listserv, AECT research participant program, the Florida State University alumni listserv, the University of South Florida alumni listserv, ISTE listserv, University of Florida listserv, and the Performance Xpress digital magazine of ISPI. All of these professional associations, institutions of higher education, and professional listservs have practicing educational technology professionals in their membership. The survey was accessible for a 3-week period, and during this time, two reminder emails were sent out to all listservs. Since so many different listservs were used to recruit respondents, response rates cannot be determined because each listserv does not have a unique membership (and an individual could belong to two or more of the listservs).

Table 1 Demographic characteristics of educational technology professional survey respondents

Demographic variable	Categories	n	%
Gender	Male	102	46.58
	Female	117	53.42
Income level	N/A	13	5.94
	$0–$30,000	18	8.22
	$30,001–$50,000	26	11.87
	$50,001–$75,000	77	35.16
	$75,001–$100,000	44	20.09
	$100,001–$150,000	32	14.61
	> $150,000	9	4.11
Race	American Indian/Alaska Native	0	0
	Asian	10	4.57
	Black/African American	0	0.00
	Hawaiian/other Pacific Islander	10	4.57
	Hispanic/Latino	13	5.94
	White/Caucasian	177	80.82
	Other	9	4.11
Sector of the economy	Public	137	62.56
	Private	82	37.44
Highest level of education	High school	2	0.91
	Associates	6	2.74
	Bachelors	21	9.59
	Masters	104	47.49
	Specialist	5	2.28
	Doctorate	81	36.99
Age range	0–25	4	1.83
	26–35	40	18.26
	36–45	56	25.57
	46–55	64	29.22
	56–65	44	20.09
	> 65	11	5.02
Current classification	Professional	193	88.13
	Intern	2	0.91
	Student	24	10.96
Number of employees at employer	N/A	14	6.39
	0–25	25	11.42
	26–150	29	13.24
	151–500	23	10.50
	501–1000	29	13.24
	1000–25,000	78	35.62
	25,001–50,000	14	6.39
	> 50,000	7	3.20

Data analysis

Data were subjected to descriptive analysis, internal consistency reliability analysis, exploratory factor analysis (EFA), and Multivariate Analysis of Variance (MANOVA). EFA was conducted to explore the underlying structure of the data collected using the ETCS and to provide meaningful labels to the factors on the ETCS. MANOVA was used to explore differences among the demographic characteristics of the survey respondents on the factors of the ETCS. All quantitative analyses were conducted using SPSS version 24. An alpha level of 0.05 was used for all statistical tests.

Results

All of the items and the descriptive statistics can be found in the Appendices organized by domain and factor label. Internal consistency reliability, as measured by Cronbach's alpha, for the scale was very high in each domain at $\alpha = 0.98$ for knowledge, $\alpha = 0.96$ for skill, and $\alpha = 0.95$ for ability. The Cronbach's alpha for the total scale is $\alpha = 0.98$. The results are organized into three sections: descriptive analysis, exploratory factor analysis, and multivariate analysis of variance.

Descriptive analysis

The descriptive analysis is intended to show the top 10 items ranked from the average scores from the ETCS in each of the domains: knowledge, skills, and abilities. These top ten items in each domain represent the highest rated items using the importance scale according to the sample of educational technology professionals. Table 2 shows the top 10 items from the knowledge domains of the ETCS. As can be gleaned, the highest rated three items are (1) knowledge of online teaching and learning, (2) formative and summative evaluation, and (3) cognitive

Table 2 Top 10 items from the knowledge domain

Rank	Knowledge of…	M	SD
1	Online teaching and learning	4.55	0.66
2	Formative and summative evaluation	4.53	0.74
3	Cognitive learning theory (e.g., cognitive load theory)	4.42	0.80
4	Blended learning techniques	4.40	0.74
5	Instructional design models and principles (e.g., Dick and Carey)	4.38	0.84
6	Face-to-face teaching and learning	4.35	0.81
7	Adult learning theory	4.32	0.81
8	Classroom-based technology integration techniques	4.32	0.86
9	Assessment methods (e.g., criterion-referenced)	4.31	0.83
10	Copyright laws	4.29	0.86

learning theory. Also, the other important items on the list are knowledge of blended learning techniques, instructional design models and principles, and face-to-face teaching and learning. While these items represent the most important knowledge items, it is also important to note items that were not included on the list or those that scored the least in this domain. Notably, several of the least scoring items include ideas such as Six Sigma ($M = 2.58$) or specialized development knowledge like programming languages ($M = 2.75$), eCommerce application development ($M = 2.80$), or server-side scripting languages ($M = 2.82$).

In the skills domain of the ETCS, the highest rated skills include oral and written communication skills, collaboration skills, creative problem-solving skills, and interpersonal communication skills. Table 3 provides the top 10 items from the skill domain of the survey ranked by the highest averaged scores. Also, notable skills include logical problem-solving skills and time management skills. Again, while the skills listed in Table 3 are the highest rated, it is also important to highlight the lowest rated skills, which as previously noted can be found in the "Appendix 1" with all of the items. Accordingly to the professional respondents to the survey, skills like database programming ($M = 2.76$), business analysis ($M = 3.06$), animation design ($M = 3.06$), finance/budgeting ($M = 3.08$), and computer programming ($M = 3.08$) are the least important skills. Conspicuously, the skills listed as least important correspond to some of the lowest scored knowledge items like programming or scripting languages.

Table 4 shows the top 10 items from the abilities domain according to the survey respondents. The ability to (1) adapt to evolving products and technology, (2) apply sound instructional design principles, and (3) work well with others (in teams) were the three top rated items on the list. Similarly, the ability to (1) adapt and acquire new things quickly, and (2) create effective instructional products were important. As shown, both working individually and with diverse stakeholders appear to be an important ability according to respondents. The last important ability statements included the ability to manage vendors ($M = 3.46$), develop computer applications and databases ($M = 3.10$), and differentiate color ($M = 3.04$). Again, a consistent theme across the three domains appears to be a de-emphasis on the programming and development skills.

Table 3 Top 10 items from the skills domain

Rank	Skill	M	SD
1	Oral and written communication skills	4.60	0.68
2	Collaboration skills	4.54	0.69
3	Creative problem-solving skills	4.53	0.72
4	Interpersonal communication skills	4.51	0.76
5	Logical problem-solving skills	4.41	0.82
6	Time management skills	4.40	0.82
7	Troubleshooting skills	4.39	0.89
8	Organizational skills	4.36	0.81
9	Self-management skills	4.33	0.85
10	Content development skills	4.22	0.85

Table 4 Top 10 items from the abilities domain

Rank	Ability to …	M	SD
1	Adapt to evolving products and technology	4.67	0.57
2	Apply sound instructional design principles	4.67	0.61
3	Work well with others (in teams)	4.63	0.62
4	Adapt and acquire new things quickly	4.61	0.63
5	Create effective instructional products	4.60	0.69
6	Exercise ethical judgment	4.58	0.66
7	Work under deadlines	4.58	0.68
8	Learn quickly and independently	4.55	0.68
9	Work independently	4.53	0.74
10	Collaborate with different team members	4.50	0.69

Exploratory factor analysis

Bartlett's test of sphericity for these data had a Chi square of 37,357.51 ($p < 0.001$), which suggested the intercorrelation matrix contained adequate common variance. The Kaiser–Meyer–Olkin measure of sampling adequacy was 0.69, which was above the 0.5 recommended limit (Kaiser 1974). Separate EFAs were conducted for each domain (knowledge, skills, ability). The participant-to-item ratio for the knowledge domain is approximately ~ 3:1, for the skill domains ~ 5:1, and for the ability domain ~ 4:1. All of the participant-to-item ratios are below the 10:1 ratio for factor analysis suggested by Kerlinger (1974) and near the thresholds described as more than adequate by some researchers in maintaining factor stability (Arrindell and Van der Ende 1985; Guadagnoli and Velicer 1988). Thus, these data appeared to be well suited for factor analysis. All EFA models were executed using principal axis factoring and an oblique (promax) rotation, as the factors were anticipated to be related. The pattern matrices can be observed in the "Appendices 2 and 3" for each of the domains. The number of factors retained was based on the Kaiser criterion (Eigenvalue > 1) and inspection of the Scree plots generated. Items were assigned to factors based on the greatest values in the pattern matrices.

Knowledge domain "Knowledge statements refer to an organized body of information usually of a factual or procedural nature" (Ritzhaupt and Martin 2014). Eighty knowledge statements derived from the conceptual framework and four step process. The EFA on these data showed that 15 factors were extracted in 38 rotations. The data did not exhibit a simple structure in the pattern matrix; however, all coefficients used to assign items to factors in the pattern matrix were above 0.30. Item 51 (mobile learning platforms) was the only item to load on factor 14, thus it was logically assigned to factor 11 (*Cloud and mobile technologies*). Item 30 loaded (copyright laws) on factor 11 as well, which did not make logical sense for naming. Therefore, we formed Item 30 (copyright laws) and item 47 (laws, policies, and procedures in training programs) to factor labeled *Copyright laws, policies, and procedures in training programs*. The factor model explained ~ 71% of the variance in these data. Table 5 provides the descriptive statistics and internal consistency reliability for the knowledge domain factors.

Table 5 Knowledge domain factors labels, descriptive statistics, and reliability

Factor label	M	SD	Skewness	Kurtosis	# of items	Cronbach's α
1: Production, authoring, and productivity software	3.82	0.73	− 0.57	− 0.27	18	0.95
2: Development methodology, software, and programming	3.12	0.76	− 0.08	− 0.54	17	0.95
3: Organizational development and management	3.55	0.71	− 0.19	− 0.18	8	0.86
4: Learning theory and human performance technology	4.18	0.65	− 0.90	0.35	5	0.78
5: Assessment, evaluation, and teaching techniques	4.35	0.60	− 1.72	4.09	5	0.81
6: Curriculum standards and frameworks	3.77	0.78	− 0.50	0.07	4	0.78
7: Learning management software and higher education	3.72	0.72	− 0.57	− 0.06	4	0.78
8: Instructional design, development, and online facilitation	4.35	0.64	− 1.23	1.34	4	0.81
9: Computer and communication hardware	3.42	1.05	− 0.28	− 0.60	2	0.93
10: Web and interface design	4.05	0.75	− 0.51	− 0.43	2	0.63
11: Cloud and mobile technologies	3.69	0.85	− 0.42	− 0.37	2	0.68
12: Content management systems and learning objects	3.62	0.83	− 0.37	− 0.14	2	0.66
13: Project management principles and software	3.30	0.95	− 0.02	− 0.63	2	0.79
14: Games, simulations, and the flipped classroom	3.65	0.76	− 0.26	− 0.34	3	0.71
15: Copyright laws, policies, and procedures in training programs	3.98	0.74	− 0.76	0.17	2	0.52

As can be gleaned in Table 5, the highest scores were the factors *Assessment, evaluation, and teaching techniques*, and *Instructional design, development, and online facilitation* tied at $M = 4.35$. Also notable and above the 4.0 threshold are the factors *Learning theory and human performance technology* ($M = 4.18$), and *Web and interface design* ($M = 4.05$). The two lowest scoring factors were *Development methodology, software, and programming* ($M = 3.12$), and *Project management principles and software* ($M = 3.30$). While not all of the factors were at the bottom or the top, it is also notable that all factors were above the 3.0 threshold on the 5-point scale of the instrument. The factors appear to be normally distributed as evidenced by the skewness and kurtosis coefficients with the exception of the *Assessment, evaluation, and teaching techniques* factor having a higher than desired kurtosis coefficient. With the exception of four of the factors, all of the internal consistency reliability coefficients are above the 0.70 social science standard (Nunnaly 1978). All internal consistency reliability coefficients are at least above the 0.50. Generally speaking, the ETCS has an internally consistent structure in the knowledge domain.

Skill domain "Skill statements refer to the adept manual, verbal or mental manipulation of things" (Ritzhaupt and Martin 2014, p. 22). There was a total of 42 skill statements derived from the conceptual model and four phase implementation of the survey. The EFA on these data showed that seven factors were extracted in seven rotations. The seven factor model explained $\sim$ 67% of the variance in these data. Again, the data did not exhibit a simple structure in the pattern matrix, yet the lowest factor loading to assign an item to a factor was 0.38. Item 7 (Computer software skills) initially loaded on the *Communication, problem-solving, and interpersonal skills*. Since this loading was not meaningful, item 7 was re-assigned to the *Development, authoring, and production* skills factor. Item 34 (Storyboard design skills) was initially assigned to the *Project and quality management skills* factor, but it was re-assigned to the *Development, authoring, and production skills* factor to interpretability. Table 6 provides the descriptive statistics and internal consistency reliability for the skills domain factors.

Table 6 shows that the three highest rated factor scores were *Communication, problem-solving, and interpersonal skills* ($M = 4.34$), *Project and quality management skills* ($M = 3.92$), and *Customer service and resolution skills* ($M = 3.78$). The only factor to score below the 3.0 threshold was the *Computer and database programming skills* ($M = 2.92$) factor, which is consistent with the findings from the knowledge domain *Development methodology, software, and programming* factor having the lowest score in that domain. With the exception of the *Communication, problem-solving, and interpersonal skills* factor having an unusually high kurtosis coefficient, the factors in the skills domain appear to be normally distributed. All of the internal consistency reliability coefficients are above the 0.70 social science standard (Nunnaly 1978) with the lowest Cronbach's $\alpha = 0.79$. The skills domain factors are internally consistent.

Table 6 Skills domain factors labels, descriptive statistics, and reliability

Factor label	M	SD	Skewness	Kurtosis	# of items	Cronbach's α
1: Communication, problem-solving, and interpersonal skills	4.34	0.58	− 1.78	5.51	13	0.93
2: Development, authoring, and production skills	3.55	0.72	− 0.27	− 0.32	10	0.90
3: Leadership and team development skills	3.64	0.84	− 0.28	− 0.47	7	0.91
4: Business and research skills	3.36	0.77	− 0.03	− 0.39	4	0.79
5: Customer service and resolution skills	3.78	0.84	− 0.50	− 0.19	4	0.82
6: Project and quality management skills	3.92	0.87	− 0.54	− 0.22	2	0.82
7: Computer and database programming skills	2.92	0.98	− 0.21	− 0.55	2	0.86

Ability domain "Ability statements refer to the capacity to perform an observable activity" (Ritzhaupt and Martin 2014, p. 22). There were 51 ability statements derived from the conceptual framework and three phases in the survey's development. The EFA on these data showed 10 factors extracted from 12 rotations. Again, the data exhibited a relatively non-simple structure in the pattern matrix. The ten factor model explained ~ 69% of the variance in these data. However, not all of the factor loading were meaningful, so some instrument design decisions were made to improve the interpretability and clarity of the factor labels. Two items, item 22 (develop computer applications and databases) and item 25 (differentiate color), were dropped from the survey because they had low factor loadings and did not fit with the other factors. Two items were re-assigned from the *Project management and providing feedback factor* to the *Instructional design, development, and evaluation* factor (item 27: evaluate learning products and programs) and to the *Adaptability to technology and process* factor (item 31: learn quickly and independently). Finally, the tenth factor in the model was dropped since only one item loaded on that factor. This item (item: advise and consult with faculty) was re-assigned to factor Work and communicate with diverse constituencies.

Table 7 shows the descriptive statistics and internal consistency reliability for the ability domain factors. As can be gleaned, only one factor had an average score below the 4.0 threshold (*Analysis and strategic management*), indicating that participants generally assigned high ratings of importance to these items. The highest rated four factors included *Adaptability to technology and process* ($M = 4.61$), *Project management and providing feedback* ($M = 4.47$), *Initiative and focus* ($M = 4.44$), and *Instructional design, development, and evaluation* ($M = 4.43$). The factors in the ability domain all appear to be normally distributed as evidenced by the skewness and kurtosis coefficients. The internal consistency

Table 7 Ability domain factors labels, descriptive statistics, and reliability

Factor label	M	SD	Skewness	Kurtosis	# of items	Cronbach's α
1: Project management and providing feedback	4.47	0.58	− 1.12	0.47	6	0.91
2: Teaching and delivery of instruction	4.09	0.73	− 0.83	0.53	7	0.90
3: Instructional design, development, and evaluation	4.43	0.52	− 1.32	2.20	9	0.84
4: Analysis and strategic management	3.78	0.71	− 0.19	− 0.42	7	0.86
5: Adaptability to technology and process	4.61	0.52	− 1.40	1.50	3	0.77
6: Work and communicate with diverse constituencies	4.41	0.55	− 0.96	0.54	5	0.79
7: Trouble-shooting and use of hardware	4.12	0.87	− 0.85	− 0.01	2	0.77
8: Initiative and focus	4.44	0.71	− 1.09	0.33	2	0.93
9: Leadership and ethical judgement	4.29	0.58	− 0.66	−0.28	6	0.85

reliability coefficients ranged from $\alpha = 0.77$ to $\alpha = 0.93$, which are all well above the social science standard of 0.7 (Nunnaly 1978). The ETCS appears to be an internally consistent scale for the ability domain.

Multivariate analysis of variance

MANOVA was employed to examine the differences among the various demographic characteristics of the educational technology professionals that responded to the survey. Specifically, this analysis examines gender, income level, ethnicity, the sector the economy the professional works in, educational level, and age range on the 31 factors in the three domains of the ETCS. Prior to running analysis, data were examined for multivariate normality, homogeneity of variance, and linearity. As there were no severe departures from the statistical test assumptions, the data appeared to be well-suited for the MANOVA. The data were entered into a MANOVA model; however, we purposefully excluded the interactions of the independent variables for parsimony in explaining the results.

Table 8 shows the results from the MANOVA model. We report the F-values and *p* values from the analysis and bold and highlight the significant variables. As can be seen, the only independent variable to not detect a difference on the various factors was Income Level. Gender showed a difference on two variables in the skills domain: *Business and research skills*, and *Project and quality management skills*. After a review, it would appear that male professional's rate the importance of *Business and research skills* and *Project and quality management skills* higher than their female counterparts. On ethnicity, we detected four statistically significant differences on *Production, authoring, and productivity software*, *Development, authoring, and production skills*, *Analysis and strategic management*, and *Leadership and ethical judgment*.

Professionals in the private sector of the economy rate the importance of *Project management principles and software* significantly more than their public sector counterparts as shown in Table 8. In terms of education level, there was a statistically significant difference on *Learning theory and human performance technology* and *Assessment, evaluation, and teaching techniques* from the knowledge domain, and *Instructional design, development, and evaluation* from the ability domain. Finally, in terms of age range, there were two statistically significant differences detected on factors from the knowledge domain: *Production, authoring, and productivity software*, and *Cloud and mobile technologies*.

Discussion

The interpretation of these results provided should be viewed in light of both the limitations and delimitations of this research. The job announcement analysis which was used to formulate many of the competencies listed on the survey only accounted for one 5-month period and primarily within the United States. As the educational technology profession is always changing, there is no guarantee the ETCS will be valid in a few years. Periodic updates to this type of survey are necessary to ensure

Table 8 MANOVA results for factors by demographic characteristics of the professionals

Demographic characteristics	Gender		Income level		Ethnicity		Sector of economy		Education level		Age range	
Domains and factor labels	F-value	*p* value	F-value	*p* value	F-value	*p* value	F-value	*p* value	F-value	*p* value	F-value	*p* value
Knowledge domain												
1: Production, authoring, and productivity software	1.18	0.28	0.77	0.60	**3.34**	**0.01**	0.00	0.97	0.49	0.78	**2.71**	**0.02**
2: Development methodology, software, and programming	0.48	0.49	0.91	0.49	0.74	0.57	0.62	0.43	0.32	0.90	1.13	0.34
3: Organizational development and management	0.79	0.37	0.53	0.78	1.73	0.14	1.36	0.25	0.70	0.63	0.50	0.78
4: Learning theory and human performance technology	0.06	0.81	2.36	0.03	1.03	0.39	2.57	0.11	**4.41**	**0.00**	0.24	0.94
5: Assessment, evaluation, and teaching techniques	0.16	0.69	1.30	0.26	1.22	0.30	0.25	0.62	**4.14**	**0.00**	0.39	0.85
6: Curriculum standards and frameworks	1.85	0.18	0.65	0.69	1.23	0.30	0.02	0.88	1.06	0.38	0.57	0.72
7: Learning management software and higher education	0.33	0.57	0.53	0.79	1.17	0.32	0.01	0.92	1.25	0.29	1.23	0.30
8: Instructional design, development, and online facilitation	1.40	0.24	0.33	0.92	0.77	0.55	1.22	0.27	1.38	0.23	1.34	0.25
9: Computer and communication hardware	0.74	0.39	1.86	0.09	0.72	0.58	0.32	0.57	0.44	0.82	1.45	0.21
10: Web and interface design	0.74	0.39	0.77	0.59	1.87	0.12	0.32	0.57	1.10	0.36	0.30	0.91
11: Cloud and mobile technologies	1.34	0.25	0.72	0.64	1.32	0.26	0.67	0.41	0.83	0.53	**2.63**	**0.03**
12: Content management systems and learning objects	0.76	0.38	1.72	0.12	0.97	0.42	1.90	0.17	0.83	0.53	0.67	0.65
13: Project management principles and software	0.41	0.52	0.79	0.58	1.78	0.13	**4.66**	**0.03**	0.14	0.98	1.74	0.13
14: Games, simulations, and the flipped classroom	0.11	0.75	0.84	0.54	0.71	0.59	3.58	0.06	0.91	0.47	1.81	0.11
15: Copyright laws, policies, and procedures in training programs	0.94	0.33	0.62	0.71	0.88	0.48	0.11	0.75	1.05	0.39	1.09	0.37
Skills domain												
1: Communication, problem-solving, and interpersonal skills	0.00	0.98	2.01	0.07	0.86	0.49	0.03	0.85	1.41	0.22	0.31	0.91

Table 8 continued

Demographic characteristics	Gender		Income level		Ethnicity		Sector of economy		Education level		Age range	
Domains and factor labels	F-value	*p* value	F-value	*p* value	F-value	*p* value	F-value	*p* value	F-value	*p* value	F-value	*p* value
2: Development, authoring, and production skills	0.01	0.94	1.85	0.09	**3.02**	**0.02**	0.24	0.62	1.24	0.29	1.39	0.23
3: Leadership and team development skills	0.58	0.45	0.35	0.91	1.59	0.18	0.26	0.61	0.99	0.42	0.07	1.00
4: Business and research skills	**7.85**	**0.01**	1.43	0.21	2.22	0.07	0.14	0.70	1.96	0.09	0.44	0.82
5: Customer service and resolution skills	0.25	0.62	0.86	0.52	1.03	0.39	0.00	0.95	0.71	0.61	0.21	0.96
6: Project and quality management skills	**4.23**	**0.04**	0.52	0.80	1.38	0.24	0.13	0.72	0.83	0.53	0.38	0.86
7: Computer and database programming skills	1.25	0.27	1.18	0.32	0.64	0.63	1.53	0.22	0.76	0.58	1.14	0.34
Ability domain												
1: Project management and providing feedback	0.06	0.80	0.31	0.93	1.01	0.40	0.26	0.61	0.74	0.59	1.62	0.16
2: Teaching and delivery of instruction	0.08	0.77	0.86	0.52	1.45	0.22	0.08	0.78	1.09	0.36	1.34	0.25
3: Instructional design, development, and evaluation	0.01	0.92	0.95	0.46	2.10	0.08	0.00	0.99	**2.91**	**0.01**	0.39	0.86
4: Analysis and strategic management	0.72	0.40	0.32	0.93	**3.99**	**0.00**	0.99	0.32	1.54	0.18	0.39	0.85
5: Adaptability to technology and process	2.60	0.11	1.06	0.39	0.96	0.43	0.44	0.51	1.66	0.15	1.72	0.13
6: Work and communicate with diverse constituencies	0.25	0.62	1.26	0.28	1.36	0.25	0.04	0.84	0.85	0.51	0.85	0.51
7: Trouble-shooting and use of hardware	0.01	0.94	1.34	0.24	1.04	0.39	0.05	0.83	1.05	0.39	1.33	0.25
8: Initiative and focus	0.78	0.38	0.66	0.69	0.76	0.55	0.58	0.45	0.33	0.90	0.96	0.44
9: Leadership and ethical judgement	0.00	0.99	0.68	0.67	**2.84**	**0.03**	0.46	0.50	1.45	0.21	0.42	0.83

Statistically significant results are bolded the content is valid and current. It is also notable that the job announcements themselves vary widely in describing the work requirements and expectations for the positions. Some are very descriptive, and others are not. The job announcements were collected from five databases relevant to the field; however, the results may have differed had we used different sources for the job announcements themselves.

As with any survey research, the quality of the information collected is a function of the honesty, backgrounds, and expertise of the professionals that responded to the survey. As every effort was made to cast a wide net of professionals in the field of educational technology by using popular listservs (e.g., ITFORUM) and professional associations (e.g., AECT), we did not use social media venues (e.g., LinkedIn) to solicit professionals to respond to the survey. Generally speaking, the professionals responding to the survey were mostly White/Caucasian from the United States, working in the public sector, and highly educated. Indeed, the results may have varied dramatically with an international perspective or had more diverse individuals (e.g., ethnicity) respond to the request. Finally, since we used listservs that have overlapping membership, we could not calculate response rates for the administration. Even with these limitations and delimitations noted, our results have provided some very interesting findings worth of discussion.

To develop the items and stems for ETCS, we followed the procedures and recommendations from Ritzhaupt and Martin (2014). This process was based on a conceptual framework operationalizing the current definition of the field and knowledge, skill, and ability (KSA) statements, and included four phases to ensure the content validity of the items: (1) an extant review of relevant literature related to competencies of educational technology professionals, (2) job announcement analysis of 400 postings from five relevant databases, (3) we extracted and merged the KSA statements from the job announcements and relevant literature, (4) administration of the survey on a wide-variety of educational technology professionals ($N = 219$). This systematic design and development process resulted in a relevant list of 176 competencies organized into KSA statements.

After securing data from the professionals, we subjected the data to a thorough analysis which included descriptive statistics, statistical assumption analysis for the subsequent techniques, Exploratory Factor Analysis (EFA), internal consistency reliability, and Multivariate Analysis of Variance (MANOVA). The EFA was executed to uncover the underlying structure of the ETCS, and organize the data into meaningful factors to explain and predict with these data. The EFA process followed sound procedures and demonstrated the construct validity of the ETCS. As further evidence of the relevance of the items and factors, one can observe that all 31 factors were above the 3.0 cut point except one factor in the skills domain: *Computer and database programming skills*. Further, an analysis of the internal consistency reliability of the three domains and 31 factors demonstrates the ETCS measures are internally consistent for these data with a few exceptions below the social science standard. Finally, we explored demographic differences among the professionals on the newly formed factors.

There were factors in each of the KSA domains that rose to the top of the list and sunk to the bottom of the list based on the average composite scores. For example, in the knowledge domain, key constructs emerged as important to the professionals, such as *Instructional design, development, and online facilitation*, *Assessment, evaluation, and teaching techniques*, and *Learning theory and human performance technology*. These domains are consistent with other research on competencies in our field (ATD 2017; IBSTPI 2017; Izmirli and Kurt 2009). The field of educational technology emphasizes topics like learning theory, assessment, evaluation, and instructional design in coursework in our academic programs. A review of professional association websites in our field show webinars, workshops, books, and other resources that are consistent with these topics. From the skills domain, the most important constructs to float to the top were *Communication, problem-solving, and interpersonal skills*, *Project and quality management skills*, and *Customer service and resolution skills*. These findings are consistent with previous research demonstrating the importance of the "soft skills" in our field, and the increasing emphasis on project management (Hartley et al. 2010; Wakefield et al. 2012).

From the ability domain, the most important factors include *Adaptability to technology and process*, *Project management and providing feedback*, and *Work and communicate with diverse constituencies*. These data tells us that educational technology professionals must be nimble and adaptable to the swiftly changing technology and processes used within our craft. The only constant aspect in our profession, it appears, is change. Again, the notion and importance of project management is highlighted and linked to prior research (Richey et al. 2001), and perhaps most importantly, the view that our professionals must be capable of working and collaborating with a diverse constituency, like programmers, graphic designers, instructional designers, project managers, customers, subject-matter experts, and more. This re-iterates the importance of our professionals having interpersonal and communication skills (Wakefield et al. 2012).

Across the three domains, we can see some themes emerging as well. Again, the importance of the craft of instructional design from analysis to evaluation was detected in the factor scores across the domains. For instance, in the knowledge domain, *Assessment, evaluation, and teaching techniques*, and *Instructional design, development, and online facilitation* were highly rated constructs. From the ability domain, the factor *Instructional design, development, and evaluation* had a high average score. Instructional design remains a hallmark to the craft of professionals in educational technology (Reiser and Dempsey 2012). Also notable was, the emphasis on project management in the practice of our labor. The ratings for project management in the *knowledge* domain have lower but still acceptable scores on the *Project management principles and software.* In the *skills* domain have high scores on *Project and quality management skills*, and the ability domains emphasizes the *Project management and providing feedback* factor. Project management has become a key curriculum area within our field's academic programs (Williams Van Rooij 2010; Williams van Rooij 2011, 2013). Professionals in our field have a high perception of the importance of what we might classify as twenty-first-century skills or abilities, including constructs like *Communication, problem-solving, and interpersonal skills*, *Customer service and resolution skills* coming from the skills domain, and *Initiative and focus* and *Leadership and ethical judgment* coming from the ability domain. These thinking skills are emphasized in other standards and competencies written for professionals in the field (Koszalka et al. 2013).

While the most important cross-cutting KSA statements are worthy of discussing, so too are those constructs that were not rated as highly by the professionals. A surprising finding was the lower than average scores assigned to computer programming related tasks with *Development methodology, software, and programming* from the knowledge domain having the lowest average score and *Computer and database programming skills* from the skills domain having the lowest average score. Computer programming knowledge and skills are not required in all educational technology programs; however, there is evidence of these skills in the job announcements within our field for positions like instructional developers or e-Learning developers (Kang and Ritzhaupt 2015). Also notable, even the development tools for authoring content did not fare as highly as some other factors with *Production, authoring, and productivity software* from the knowledge domain having an average score, and *Development, authoring, and production skills* from the skills domains with an average score. Several of our academic programs emphasize authoring and development tools (e.g., Adobe Captivate), and professional development experiences from our professional associations often include these tools and topics.

The MANOVA demonstrated some differences on the ETCS factors based on demographic characteristics, such as Gender, Income Level, Ethnicity, Sector of Economy, Education Level, and Age Range. For instance, it appears that females in the profession rate the factors of *Business and research skills*, and *Project and quality management skills* of lower importance than their male counterparts. Another example is that professionals in the private sector of the economy rate the importance of Project management principles and software significantly more than their public sector counterparts. It is important to examine these differences to understand the diverse background and experiences of the professionals who need the KSA domains to conduct their work. Other differences were noted in the results section; however, we do not know how or why these differences of perspective exist. This is a ripe opportunity for future research by other scholars in the field.

Recommendations future research

The instrument and conceptual framework employed in this research can be used by other researchers to conduct longitudinal research, predictions into the future, and comparisons. Do the competencies of professionals work in the field change over time? Evidence from the standards for instructional designers has evolved over time (Koszalka et al. 2013). How do they change and are their constants to the practice of our work? Are there differences among contexts (e.g., higher education, military, government, K-12 education, etc.) or demographics traits (e.g., gender)? Are academic program and their curricula meeting the twenty-first century competencies for professionals in our field? Unfortunately, we do not have conclusive answers to many of these questions from the research base. Tools like the ETCS can assist researchers in measuring, predicting the competencies into the future, or even exploring meaningful comparisons. As with any valid and reliable research, we need measures built on the existing theory that meet the social science standards of evidence (e.g., construct validity) to accomplish these goals. Future research should also seek to collect a larger and more diverse sample of professionals to utilize confirmatory factor analysis to test the hypothesized structure proposed in this study. We believe the ETCS hold promise as a valid and reliable measurement system.

Recommendations for practice

We believe the findings of this research have a direct link to professional practice. Based on our results, we can provide recommendations to employers, educational technology programs, and professionals. These recommendations are intended to assist in using the results from this study to better inform practice. To employers, we suggest providing employees ongoing professional development opportunities to keep abreast in a swiftly evolving field. Opportunities for learning about new instructional design processes (e.g., SAMR model) or newer development tools (e.g., Articulate Storyline), or authoring languages (e.g., HTML 5). These professional development opportunities can be job-embedded (Zepeda 2014) in which the knowledge, skills and abilities learned can be directly linked to job assignments in their professional career. Also as noted by Ritzhaupt et al. (2010), the job announcements written by employers can benefit from the use of the KSA statements used in the ETCS to improve the communication of expectation to potential candidates.

Professionals should examine the competencies listed in this study to identify gaps in the learning. The competencies listed can be used to develop a personal learning plan to grow professionally or have career mobility. Professionals should also actively seek professional development opportunities for expanding their practice from both their employers and their professional associations. Professionals should attend webinars, workshops, short courses, trade conferences, and any in-house training and development functions offered by their employer to grow professionally. Professional associations have an enormous responsibility to advocate for the professionals in our field. Thankfully, we have a host of professional associations linked to our professional practice, including the Association for Educational Communications and Technology (AECT), International Society for Technology in Education (ISTE), International Society for Performance Improvement (ISPI), Association for Talent Development (ATD), or Association for the Advancement of Computing in Education (AACE). These professional associations should continue to build robust networks, professional development opportunities, curriculum standards, and professional certifications (e.g., CPT or CPLP) that align with the relevant findings from the present study.

Closing remarks

We close this discussion by making a call to the educators, researchers, and practitioners in our field to actively review and periodically update their repertoire of knowledge, skills, and abilities by using this research on competencies. As noted previously, the vast majority of the factors and individual items on the ECTS were above the middle-point on the survey, indicating that professionals generally agree that the content within is relevant. We also close by highlighting the diverse portfolio of knowledge, skills, and abilities the professionals in our field. As evidenced by this work and the body of knowledge supporting this work, educational technologists are highly sophisticated professionals drawing upon both the human and technological side of our society. The competencies of educational technologists could vary based on the context (e.g., country, institution, job title etc.). Therefore, it might be important to expand this research taking the institutional or cultural aspects into account to examine educational technology competencies for various settings.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1: Knowledge domain items

Factors/items (knowledge of…)	M	SD
Factor 1: Production and productivity software	3.82	0.73
Data communications (e.g., FTP)	3.45	1.05
Audio software (e.g., Audacity)	3.80	1.00
Authoring tools (e.g., Captivate)	4.01	0.96
Bitmap image software (e.g., Photoshop)	3.74	0.96
Educational authoring software (e.g., Articulate, Lectora)	3.82	0.99
Operating system software (e.g., Windows 7)	3.71	1.09
Presentation software (e.g., PowerPoint)	4.05	0.92
Screen recording software (e.g., Camtasia)	3.95	1.00
Social media technologies (e.g., Twitter)	3.86	0.98
Spreadsheet software (e.g., Excel)	3.82	0.98
Streaming video technology (e.g., Windows Media Server)	3.79	0.97
Video software (e.g., Premiere)	3.56	1.00
Virtual classrooms (e.g.,Wimba or Elluminate! Live)	3.90	0.98
Virtual environments (e.g., SecondLife)	3.30	1.11
Web 2.0 technology (e.g., Wikis, Blogs, Podcasts, etc.)	4.15	0.91
Web authoring tools (e.g., Dreamweaver)	3.66	1.05
Web-based data collection tools (e.g., SurveyMonkey)	3.92	0.94

Factors/items (knowledge of…)	M	SD
Word processing software (e.g., Word)	4.27	0.94
Factor 2: Development methodology, software, and programming	3.12	0.76
3D modeling tools (e.g., Maya)	2.93	1.04
Accessibility software (e.g., JAWS)	3.51	0.98
Agile methodology (e.g., Scrum)	3.20	1.05
Business intelligence (e.g., SAP BW)	2.89	1.01
Cascading Style Sheets (CSS)	3.27	1.02
Client-side scripting languages (e.g., JavaScript)	3.09	1.04
Database software (e.g., Access)	3.33	0.94
Desktop publishing software (e.g., PageMaker)	3.43	1.03
eCommerce application development	2.80	1.03
Flash (and ActionScript)	3.08	1.06
Markup languages (e.g., HTML/XHTML/XML)	3.50	1.04
Mobile application development	3.53	1.03
Programming languages (e.g., C ++)	2.75	1.07
Server-side scripting languages (e.g., PHP)	2.82	1.10
Six Sigma	2.58	1.06
Statistical analysis tools (e.g., SPSS)	3.19	1.05
Vector image software (e.g., Illustrator)	3.17	1.08
Factor 3: Organizational development and management	3.55	0.71
Cost–benefit analyses	3.65	0.95
Customer service	3.89	1.02
Global and local training planning	3.52	1.01
Human resources management	3.10	1.03
Organizational development	3.56	0.96
Professional development	4.00	0.91
SWOT analysis	3.28	1.13
Theories of leadership	3.38	1.06
Factor 4: Learning theory and human performance technology	4.18	0.65
Human Performance Technology principles	4.01	0.94
Adult learning theory	4.32	0.81
Cognitive learning theory (e.g., Cognitive Load Theory)	4.42	0.80
Constructivism	4.12	0.93
Motivation theories (e.g., ARCS)	4.04	0.93
Factor 5: Assessment, evaluation, and teaching techniques	4.35	0.60
Formative and summative evaluation	4.53	0.74
Accessing and analyzing data	4.16	0.85
Assessment methods (e.g., criterion-referenced)	4.31	0.83
Blended learning techniques	4.40	0.74
Face-to-face teaching and learning	4.35	0.81
Factor 6: Curriculum standards and frameworks	3.77	0.78
Twenty-first-century skills frameworks (e.g., P21)	3.94	1.02
Classroom-based technology integration techniques	4.32	0.86

Factors/items (knowledge of…)	M	SD
Common Core State Standards (CCSS)	3.32	1.12
STEM (i.e., Science, Technology, Engineering, and Mathematics)	3.53	1.02
Factor 7: Learning management software and higher education	3.72	0.72
Learning Management Systems (e.g., Blackboard)	4.14	0.86
Synchronous distance learning methodologies (e.g., Blackboard Collaborate)	4.15	0.84
Assessment software (e.g., Respondus)	3.58	1.00
College/university administration	3.01	1.02
Factor 8: Instructional design, development, and online facilitation	4.35	0.64
e-Learning development	4.25	0.84
Instructional design models and principles (e.g., Dick and Carey)	4.38	0.84
Online teaching and learning	4.55	0.66
Online/blended program management	4.21	0.88
Factor 9: Computer and communication hardware	3.42	1.05
Communications hardware	3.37	1.09
Computer hardware	3.47	1.07
Factor 10: Web and interface design	4.05	0.75
Interface design	3.95	0.88
Web design principles	4.15	0.87
Factor 11: Cloud and mobile technologies	3.69	0.85
Cloud technologies	3.75	0.96
Mobile learning platforms (e.g., Android)	3.63	0.99
Factor 12: Content management systems and learning objects	3.62	0.83
Content management systems (e.g., Joomla)	3.60	0.96
Learning object standards (e.g., SCORM)	3.63	0.97
Factor 13: Project management	3.30	0.95
Project management principles (e.g., PMBOK)	3.44	1.05
Project management software (e.g., Microsoft Project)	3.16	1.05
Factor 14: Games, simulations, and the flipped classroom	3.65	0.76
Flipped classroom	3.96	0.97
Game engines (e.g., Unity)	3.18	1.00
Instructional simulation and game design	3.82	0.90
Factor 15: Copyright laws, policies, and procedures in training programs	3.98	0.74
Copyright laws	4.29	0.86
Laws, policies, and procedures in training programs	3.68	0.94

Appendix 2: Skills domain

Factors/items (skills)	M	SD
Communication, problem-solving, and interpersonal skills	4.21	0.56
Analytical/technical documentation skills	4.03	0.91
Collaboration skills	3.51	1.00
Content development skills	3.06	0.98
Creative problem-solving skills	4.54	0.69
Editing and proofing skills	4.22	0.85
Interpersonal communication skills	4.53	0.72
Logical problem-solving skills	4.05	0.86
Oral and written communication skills	4.51	0.76
Organizational skills	4.41	0.82
Relationship building skills	4.60	0.68
Self-management skills	4.36	0.81
Time management skills	4.16	0.89
Troubleshooting skills	4.33	0.85
Development and production skills	3.55	0.72
Animation design skills	3.06	1.06
Audio production skills	3.51	1.00
Game and simulation skills	3.30	1.06
Graphic design skills	3.61	0.98
Print design skills	3.22	1.04
Typing skills	3.64	1.07
Video production skills	3.64	0.98
Web development skills	3.73	0.95
Storyboard design skills	3.67	0.97
Computer software skills	4.15	0.84
Leadership and team development skills	3.64	0.84
Coaching skills	3.68	1.07
Leadership skills	3.86	1.07
Mentoring skills	3.69	1.05
Negotiation skills	3.70	1.05
Tactical and strategic planning skills	3.69	1.05
Talent management skills	3.09	1.08
Team building skills	3.82	1.01
Business and research skills	3.36	0.77
Business analysis skills	3.06	0.98
Finance/budgeting skills	3.08	0.93
Research skills	4.00	0.90
Statistical analysis skills	3.29	1.09
Customer service and resolution skills	3.78	0.84

Factors/items (skills)	M	SD
Conflict-management skills	3.73	1.00
Coping skills	3.78	1.03
Customer service skills	3.97	1.05
Interviewing skills	3.62	1.10
Project and quality management skills	3.92	0.87
Project management skills	4.00	0.92
Quality control skills	3.84	0.96
Computer and database programming skills	2.92	0.98
Computer programming skills	3.08	1.08
Database programming skills	2.76	1.01

Appendix 3: Ability domain

Factors/items (ability to…)	M	SD
Factor 1: Project management and providing feedback	4.47	0.58
Manage multiple projects	4.35	0.85
Manage multiple tasks	4.45	0.77
Prioritize tasks	4.45	0.69
Provide critical feedback	4.36	0.72
Work under deadlines	4.58	0.68
Work well with others (in teams)	4.63	0.62
Share constructive feedback	4.67	0.57
Work independently	4.46	0.78
Factor 2: Teaching and delivery of instruction	4.09	0.73
Act as a liaison with other departments	4.12	0.85
Create workshops	4.11	0.85
Deliver training to learners	4.29	0.84
Demonstrate policies, procedures, and new information	3.95	0.91
Develop in-person training	4.24	0.88
Teach face-to-face	3.89	1.09
Teach in virtual learning environments	4.02	0.96
Factor 3: Application of instructional design, development, and evaluation	4.43	0.52
Apply sound instructional design principles	4.67	0.61
Articulate the basic concepts, terms, and theory of instructional design	4.48	0.77
Create effective instructional products	4.60	0.69
Develop assessments	4.29	0.77
Develop course materials	4.38	0.84

Factors/items (ability to…)	M	SD
Evaluate learning products and programs	4.38	0.72
Use data to make educationally sound decisions	4.30	0.72
Write learning objectives	4.40	0.84
Accommodate different learning styles	4.34	1.03
Factor 4: Analysis and strategic management	3.78	0.71
Advise or supervise employees	3.64	1.02
Analyze complex data	3.82	0.90
Analyze industry trends in learning technologies	4.12	0.81
Breakdown a business process	3.59	1.00
Manage teams	3.78	1.00
Manage vendors	3.46	1.12
Translate strategic goals	4.06	0.87
Factor 5: Adaptability to technology and process	4.61	0.52
Adapt and acquire new things quickly	4.61	0.63
Adapt to evolving products and technology	4.67	0.57
Learn quickly and independently	4.55	0.68
Factor 6: Work and communication with diverse constituencies	4.41	0.55
Advise and consult with faculty	4.46	0.78
Build strong client relationships	4.11	0.88
Collaborative different team members (e.g., working with designers, programmers, engineers, and project managers)	4.50	0.69
Communicate complex material	4.49	0.65
Work with diverse constituencies (e.g., smes and clients)	4.49	0.74
Factor 7: Trouble-shooting and use of hardware	4.12	0.87
Troubleshoot technical problems	4.14	0.95
Use audio/visual equipment	4.10	0.98
Factor 8: Initiative and focus	4.44	0.71
Be a self-starter	4.43	0.73
Be goal-oriented	4.45	0.73
Factor 9: Leadership and ethical judgment	4.29	0.58
Evaluate complex issues	4.17	0.82
Exercise ethical judgment	4.58	0.66
Inspire and influence people	4.08	0.86
Integrate theory and research into practice	4.47	0.71
Recognize opportunities and takes action	4.22	0.78
Think strategically	4.23	0.80
Items removed from analysis		
Develop computer applications and databases	3.10	1.15
Differentiate color	3.04	1.28

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