Educational Technology Competencies: Comparing General and Special Education Teacher Candidates

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This study explored the self-reported educational technology (ET) competencies of general and special education teacher candidates, based on the new ISTE Standards for Educators. Overall, the teacher candidates' ET competency level did not meet the proficient level required by these standards. Notably, special education teacher candidates scored significantly lower than their general education multiple-subject counterparts in overall ISTE competency, particularly in the Learner, Citizen, Collaborator, and Designer standards. Teacher candidates' perceptions of their program's effectiveness, as well as their age, occupation, and team-teaching experience, affect their ISTE skill levels, regardless of where they learned their ET skills. Therefore, teacher preparation programs should shift from merely acquiring ET skills to embedding these skills effectively in teaching practices by integrating ISTE Standards within curricula.

Keywords: educational technology competencies; ISTE standards for educators; teacher candidates, teacher education, special education.

INTRODUCTION

Advances in technology have empowered learners and redefined the traditional relationship between educators and students (Office of Education Technology, 2017). Rather than simply passing on information, educators as co-learners alongside their students must be able to effectively use technology to learn, collaborate, lead, and empower students to deliver real-world learning experiences. This will enable students to become active agents of learning experiences, where they can deepen their content understanding and gain real-world experience (Ebner, 2022). Educators are also expected to address the digital divide that students increasingly face in the technology-enriched learning environment (Office of Education Technology, 2017). The digital divide refers to the gap in opportunities to have access to digital resources as well as how these digitals are used to support learning. Especially, the smarter environment (e.g., access to online

learning and digital tools) seems to increase the information divide for people with disabilities (Macdonald & Clayton, 2013; Nam & Park, 2017). As more students with disabilities are educated in general education classrooms, collaboration and teamwork among educators become increasingly important, as does implementing effective use of technology for both educators and students (Dalton & Roush, 2010; Jortveit & Kovač, 2022). However, general education teachers report low levels of support from special education teachers concerning technology integration to meet the diverse learning needs of students with disabilities (Coleman et al., 2015; Okolo & Diedrich, 2016). Furthermore, there is a widening divide between students with disabilities and their peers regarding digital skills and the use of applications. Compared to their peers, students with learning disabilities (LD) were found to be less competent in information and communication technology skills, even when there was no difference in their opportunities to access computers and the internet at home and school. Moreover, students without LD enhanced their computer competency gradually each year while those with LD did not (Wu et al., 2014). Without thoughtful intervention and attention to how technology is used in learning, the digital use gap could increase as access to technology rises in schools (Office of Education Technology, 2017).

The National Education Technology Plan (NETP), developed by the U.S. Department of Education's Office of Educational Technology demanded that teacher preparation programs rethink instructional approaches and techniques, tools, and the skills and expertise of teachers reflecting changing roles and practices of teachers in technology-enriched learning environments. In particular, the NETP recommends that teacher preparation programs adopt a common set of technology competency expectations for teacher candidates to design and implement technology-enabled learning environments effectively (Office of Educational Technology, 2017). Consequently, state offices of education and school districts have implemented teaching performance expectations in which new teachers are expected to demonstrate knowledge and skills of effective teaching strategies aligned with the internationally recognized educational technology (ET) standards. These recent moves to incorporate ET standards-aligned teaching performance expectations have made a deliberate effort to systematically address disparity issues among traditionally underserved populations, particularly those with disabilities. For example, California Commission on Teacher Credentialing (CTC) requires both general and special education teacher candidates to model digital literacy and ethical digital citizenship. All beginning teachers are required to create inclusive learning environments in person or online to provide effective instruction and assessment for all students including those with disabilities (Commission on Teacher Credentialing, 2021).

Responding to the recent movement toward ET standards-aligned teaching performance, this study aimed to examine ET competency levels of general and special education teacher candidates based on a common set of technology competency expectations that require new teachers to empower students' learning while bridging the digital divide. We were also interested in exploring various factors contributing to the ET competency level of the teacher candidates, including the impact of their teacher preparation programs. We anticipate that our findings will provide meaningful insights into restructuring teacher preparation programs to align with ET standards that reflect changing roles of educators in technology-enabled learning environments.

LITERATURE REVIEW

EDUCATIONAL TECHNOLOGY STANDARDS FOR ALL EDUCATORS

Interstate Teacher Assessment and Support Consortium (InTASC), established by the Council of Chief State School Officers, has updated its Module Core Teaching Standards

that outline what teachers should know and be able to do to ensure every PK-12 student is ready for postsecondary education or employment in the 21st century (Council of Chief State School Officers [CCSSO], 2013). InTASC Module Core Teaching Standards emphasize the power of technology as it has made learners more independent and collaborative. Cross-disciplinary skills such as communication, collaboration, critical thinking, and the use of technology are incorporated into the 10 InTASC Core Teaching Standards because of their importance for learners. These updated 10 core teaching standards aim to transform a public education system that can "empower every learner to take ownership of their learning" and articulate a new vision of teaching for improved student achievement (CCSSO, 2013, p.3). Accordingly, 14 technology-referenced indicators are weaved through across the 10 core teaching standards (CCSSO, 2013).

The Council for the Accreditation of Educator Preparation (CAEP) has newly adopted the 2022 CAEP standards and one of the highlighted changes is that "specific standards for technology have been added, given the increase in online learning" (Council for the Accreditation of Educator Preparation, n.d.). The InTASC and CAEP standards both require new teachers to be prepared to use and integrate technology within teaching and learning. (Foulger et al., 2017). Although the InTASC and CAEP standards serve as useful guides for teachers' overall professional development and support by teacher preparation programs, it is not easy to measure the ET competency level of teacher candidates as they do not provide a complete set of ET standards for teachers (Kimm et al., 2020).

THE ISTE STANDARDS FOR EDUCATORS

The International Society of Education and Technology (ISTE) updated its ISTE Educator Standards in 2017, based on the recommendation of the NETP, to reflect the various roles of educators enabled by technology to empower learning (Trust, 2018). The internationally recognized ISTE Standards for Educators can guide teacher preparation programs in preparing future teacher candidates to cultivate 21st-century skills and learning environments for PK-12 students (International Society for Technology in Education [ISTE], 2017). Table 1 briefly defines the roles that educators should play for each standard. Adopting the ISTE Standards for Educators to measure technology competencies is beneficial because it examines the multifaceted roles and capabilities of teachers (Kimm et al., 2020).

Table 1. *The ISTE Standards for Educators of 2017*

Roles	Standards	Focus*	Alignment to NEPT
Learner	Educators continually improve their practice by learning from and with others and exploring proven and promising practices that leverage technology to improve student learning.	Informal, teacher-driven learning opportunities that can positively impact teacher learning and practice	Educators can be co-learners with students and peers.
Leader	Educators seek opportunities for leadership to support student empowerment and success and to improve teaching and learning.	Becoming advocates for the use of technology to bridge the digital divide and empower all students as learners	Educators can lead the evaluation and implementation of new technologies for learning.
Analyst	Educators understand and use data to drive their instruction and	Use of technology to showcase students'	Educators can become catalysts to serve the underserved.

	support students in achieving their learning goals.	knowledge and skills in a variety of ways.	
Collaborator	Educators dedicate time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems.	Use of digital tools and virtual conference tools and social media sites that support social learning beyond the traditional classrooms	Educators can collaborate far beyond the walls of their schools.
Designer	Educators design authentic, learner-driven activities and environments that recognize and accommodate learner variability.	Best practices and research related to technology-empowered learning	Educators can design highly engaging and relevant learning experiences through technology.
Facilitator	Educators facilitate learning with technology to support student achievement of the 2016 ISTE Standards for Students.		Educators can be guides, facilitators, and motivators of learners.
Citizen	Educators inspire students to positively contribute to and responsibly participate in the digital world.	Becoming digital citizens who use technology to positively contribute to society	

*Note. * The "focus" descriptions for each standard were cited from Trust (2018).*

The ISTE Standards for Educators include 24 indicators for seven standards (i.e., Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst) related to the roles and practices of educators in technology-supported learning that the 2017 NETP has envisioned:

> Educators can (a) collaborate far beyond the walls of their schools; (b) design highly engaging and relevant learning experiences through technology; (c) lead the evaluation and implementations of new technologies for learning; (d) be guides, facilitators, and motivators of learners; (e) be co-learners with students and peers; and (f) become catalysts to serve the underserved. (Office of Educational Technology, 2017, pp 28-34)

Unlike the InTASC standards, which outline general teaching performance standards, the ISTE Standards for Educators are described as "aspirational." They define what is possible "through effective technology use" and help "educators set professional learning goals for themselves" (ISTE, 2017, p. 25). Thus, the ISTE Standards can serve as a practical framework for professional development. For instance, Michaeli et al. (2020) demonstrated that educational dashboards significantly enhanced the professional development of Israeli primary school teachers, especially in data-driven decision-making roles such as facilitation, analysis, and design. When we adopt the ISTE Standard for Educators as a benchmark for professional development, their suitability as performance criteria for evaluating teacher candidates' ET competencies becomes apparent (Kimm et al., 2020). However, it is important to note that teacher candidates are not expected to demonstrate the proficiency level required by the ISTE Standards for Educators upon completing their

teacher preparation program. Instead, these standards should be viewed as ongoing professional learning goals, guiding future teachers throughout their careers (Trust, 2018). This approach encourages continuous development and integration of ET skills in teaching, aligning with the more technology-enriched learning environment for more diverse learners (Office of Educational Technology, 2017).

We particularly appreciate how the ISTE Standards for Educators aim to bridge the digital divide by providing standards that directly address students with unique learning needs. For example, one of the Leader standard indicators encourages teachers to advocate for technology use as a means to bridge the digital divide and empower all students as learners. Trust (2018) notes, "when teachers become leaders and advocates for student equity and access to technology, they can help shrink the impact of the digital divide" (p. 1). The Designer standard expects teachers to utilize technology to create, adapt, and personalize learning experiences. This includes fostering independent learning and accommodating students' varying needs, such as employing assistive technology (ISTE, 2017, p15). The Analyst standard promotes the application of the universal design for learning (UDL) principle for authentically assessing students' performance in multiple ways (Hall et al., 2012). Moreover, these seven standards align with the four intertwined components of the high-leverage practices required in special education: collaboration, assessment, social/emotional/behavioral practices, and instruction (McLeskey et al., 2017). Therefore, the ISTE Standards for Educators provide concrete indicators to assess the ET competency levels within teacher preparation programs, preparing all prospective teachers to work with diverse learners, including those with disabilities.

ET COMPETENCIES OF TEACHER CANDIDATES BASED ON THE ISTE STANDARDS

Since the update of ISTE Standards for Educators in 2017, several studies have assessed the ET competencies of pre-service and in-service teachers based on these standards (Almisad, 2020; Baek & Sung, 2021; Kimm et al., 2020). Almisad (2020) explored the perception of Kuwaiti student teachers regarding their achievement of the ISTE standards and examined the differences in these perceptions based on gender, age, major, academic year, technological competence, attitudes towards technology use, and the extent of technology use. The study found that student teachers' achievements were significantly related to their attitude toward technology use, perception of technological competence, and the extent of technology use. However, this study has limitations as it utilized the ISTE Standards for Students, not for Educators. For example, the relatively low average scores on the Computational Thinker standard could be attributed to the fact that this standard is not typically emphasized in higher education (Almisad, p. 78). This finding underscores the importance of using the ISTE Standards for Educators when assessing the ET competencies of prospective teachers.

Michaeli and colleagues (2020) investigated the associations between Israeli elementary teachers' use of education dashboards and their professional development in the framework of the ISTE Standards for Educators. They developed 23 self-reported items based on the indicators of the ISTE Standards for Educators, focusing on those relevant to the use of education dashboards. The findings indicated no significant association between the teachers' demographic and teaching-related variables and their professional growth as per the ISTE standards. However, a positive association was observed between their use of education dashboards and professional growth in roles such as facilitators, analysts, and designers, as outlined by the ISTE Standards for Educators. The study suggested that the significant associations with the facilitator and designer standards could be due to their direct relevance to traditional teachers' responsibilities. This study shows why we need to

investigate competency levels for the seven standards as well as the overall ISTE Standards for Educators.

Baek and Sung (2021) used the Teacher Preparation Technology Inventory (TPTI, Riegel, 2019) to examine pre-service elementary teachers' perception of technology competencies in South Korea. The TPTI with 81 items, was designed to evaluate the extent to which teacher preparation programs align with the 2013 CAEP (e.g., "providers ensure that candidate's model and apply technology standards" [standard 1.5]). It measures the frequency with which teacher candidates modeled and applied the 2017 ISTE Standards for Educators. Participants were prompted to reflect on their teacher preparation courses and respond to each question on a 0-5 point Likert Scale. The study, involving 342 South Korean elementary education candidates, revealed lower-end scores (e.g., 1.48), indicating they "rarely (in approximately 20% of courses)" and "sometimes (40% of courses)" modeled and applied the 2017 ISTE Standards for Educators. These findings suggest that teacher candidates perceived their technology education courses as lacking, not adequately tailored to their technology competencies levels, and not strategically integrated. Riegel (2019) acknowledged potential limitations of the TPTI, including "respondent fatigue" due to the survey's length and the possibility of "participant memory error" (p.220).

Kimm et al. (2020) conducted a study to assess the technology competencies of general and special education teacher candidates in California. They used a 31-item self-assessment survey, which was developed based on the new ISTE Educator Standards of 2017. This study is notable for including both general and special education teacher candidates. The results indicated that although teacher candidates felt they had not achieved the proficient level of technology competency outlined by the ISTE standards, they exhibited relatively higher competencies in the Learner, Citizen, and Collaborator sub-standards. However, it is noteworthy that more than half of the teacher candidates believed that their preparation programs did not sufficiently equip them with opportunities to develop their technology competencies. While this study provided encouraging insights, it did not explore how teacher preparation programs impact the ET competency levels of teacher candidates. Further investigation into how prospective teachers perceive the program's role in enhancing their current ET skills could offer valuable insights for designing teacher preparation programs.

THE PURPOSES OF THE STUDY

The purposes of this study were to evaluate the current levels of the standards-based ET competencies among general and special education teacher candidates and to identify the contributing factors. This involved assessing the teacher candidates' ET competencies using two metrics: (a) the seven standards of the 2017 ISTE Standards of Educators (Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst) and (b) the total ISTE competency level, which is a composite mean score derived from all seven standards. Additionally, the study aimed to understand the teacher candidates' perceptions of their teacher preparation program's contribution to their ET skills, replicating the research conducted by Kimm et al. (2020). The study was guided by the following research questions:

1. What is the current status of teacher candidates' ET competencies as measured by the self-assessment questionnaire aligned with the 2017 ISTE Standards for Educators?

2. Is there a difference in ET competencies between general (multiple-subject, single-subject) and special education teacher candidates as measured by the self-assessment questionnaire aligned with the 2017 ISTE Standards for Educators?

3. How do teacher candidates perceive the impact of their teacher preparation program on their current ET skills?

4. What are the significant contributing factors to the total ISTE competency level of teacher candidates?

METHODOLOGY

The purposes of this study were to evaluate the current levels of the standards-based ET competencies among general and special education teacher candidates and to identify the contributing factors to the overall ET competency of teacher candidates based on the 2017 ISTE Standards for Educators. We used a cross-sectional survey method to understand the current level of ET competencies of teacher candidates.

PARTICIPANTS AND PROCEDURE

The participants were teacher candidates enrolled in teacher preparation programs at two public universities in Southern California. Both universities show a diverse racial/ethnicity distribution with the majority of Latinx students and offer three separate teaching certification preparation programs: (a) a multiple-subject credential program for elementary school teachers, (b) a single-subject credential program for secondary school teachers, and (c) a special education program for PK-12 special education teachers. The participants are defined as teacher candidates as they have yet to obtain their teacher certification for the respective program, regardless of their current teaching position.

With approval from the institutional review boards of both universities, the authors contacted 27 instructors of teacher preparation courses to explain the study's purpose. We strategically reached out to ensure a representative sample across cohorts (Year 1 and Year 2) and program types (multiple-subject, single-subject, and special education). With the 20 instructors' permission, the authors or graduate students visited 18 classes and administered the survey to teacher candidates who consented to participate. Two classes in the special education program were fully online courses. Instructors provided the survey link to their students. In-class surveys had a response rate of 98.6% (348 out of 353), while online surveys had a response rate of 65% (42 out of 63). Of 390 participants who consented to participate, 377 respondents completed all 34 questions related to ET competencies. All 377 participants were included in the final data analysis. Table 2 provides the complete demographic and teaching-related information for the participants by their preparation program types: multiple-subject, single-subject, and special education.

Table 2. *Participants' Demographic and Teaching-Related Information by Preparation Program Types*

Demographic characteristics	Multiple-subject		Single-subject		Special education		Total*	
	n	(%)	*n*	(%)	*n*	(%)	*n*	(%)
	77	(20.4)	154	(40.8)	122	(32.4)	353	(100)
Age								
24 or younger	18	(23.7)	54	(35.5)	28	(23.0)	100	(28.6)
25-34	41	(53.9)	82	(53.9)	65	(53.3)	188	(53.7)
35 or older	17	(22.4)	16	(10.5)	29	(23.8)	62	(17.7)
Total	76	(100.0)	152	(100.0)	122	(100.0)	350	(100.0)
Gender								
Female	61	(80.3)	100	(65.4)	86	(71.1)	247	(70.6)
Male	15	(19.7)	53	(34.6)	35	(28.9)	103	(29.4)
Total	76	(100.0)	153	(100.0)	121	(100.0)	350	(100.0)
Cohort								
1st year	44	(57.1)	89	(57.8)	65	(53.3)	198	(56.1)

2nd year	33	(42.9)	65	(42.2)	57	(46.7)	155	(43.9)
Total	77	(100.0)	154	(100.0)	122	(100.0)	353	(100.0)

Currently teaching							
No	41	(53.2)	89	(58.2)	70	(57.4)	200	(56.8)
Yes	36	(46.8)	64	(41.8)	52	(42.6)	152	(43.2)
Total	77	(100.0)	153	(100.0)	122	(100.0)	352	(100.0)

Current job							
Full-time teacher	23	(29.9)	14	(9.1)	37	(30.3)	74	(21.0)
Substitute teacher	14	(18.2)	45	(29.2)	29	(23.8)	88	(24.9)
Paraprofessional	15	(19.5)	19	(12.3)	19	(15.6)	53	(15.0)
Other	25	(32.5)	76	(49.4)	37	(30.3)	138	(39.1)
Total	77	(100.0)	154	(100.0)	122	(100.0)	353	(100.0)

Team-teaching experience							
No	39	(50.6)	81	(53.3)	80	(70.2)	200	(58.3)
Yes	38	(49.4)	71	(46.7)	34	(29.8)	143	(41.7)
Total	77	(100.0)	152	(100.0)	114	(100.0)	343	(100.0)

Note. * The total percentage does not add up to 100, as not all the participants answered the demographic and teaching-related questions.

MEASURES

The survey used a questionnaire that Kimm et al. (2020) developed based on the newly adopted ISTE Standards of Educators (2017). This self-assessment questionnaire contains three components that ask respondents (a) demographic and teaching-related information, (b) the current set of ET skills and the impact of their teacher preparation program on their ET skills, and (c) ET competencies aligned with the 2017 ISTE Standards for Educators.

DEMOGRAPHIC AND TEACHING-RELATED INFORMATION

Ten items ask participants' gender, age, enrolled program, and teaching-related information. Teaching-related information items include current teaching status, grade level they are currently teaching (or interested in if they are not teaching), primary subject area of teaching, years of classroom experience, job title, school size they are working at, and team-teaching opportunity.

THE CURRENT SET OF ET SKILLS

Two items inquire about teacher candidates' current set of ET skills. First, how much the current teacher preparation program has improved their ET skills. Second, where participants acquired their current ET skill set (e.g., teacher-preparation program, self-taught, or previous schooling, etc.).

ET COMPETENCIES ALIGNED WITH THE 2017 ISTE STANDARDS FOR EDUCATORS

Based on the 2017 ISTE Standards for Educators, a total of 31 items derived from seven standards (Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst) ask a participant to "check the number that best describes your technology

competency level" ranging from 1 to 5: not familiar with (1), have an idea of what I need to work with (2), somewhat experienced and knowledgeable (3), experienced, proficient, and knowledgeable (4), and integration of multiple tools at a high level of functionality (5). Cronbach's alpha was calculated to measure the internal consistency and reliability among items in each standard. All seven standards had high reliabilities, ranging from .76 to .92 (Table 3).

Table 3. *Seven Standards and Cronbach's Alpha Values*

Standards	Items	Cronbach's alpha	Indicators
Learner	3	.76	Participating in online learning networks; staying current trends; and setting professionals to learn digital tools and resources
Leader	4	.87	Modeling for adopting new digital tools and resources for learning; empowering students to use technology; engaging with educational stakeholders; and advocating for equitable accessibility
Citizen	5	.88	Establishing a safe digital culture; protecting student data privacy; mentoring students in the safe, ethical, and legal practice with digital tools and content; creating positive and responsible online contributions; and modeling and promoting the best practices of managing personal data and digital identify
Collaborator	4	.85	Using collaborative tools; collaborate with colleague to create real-world learning experiences; use technology to collaborate and interact with culturally diverse people; and collaborate and co-learn with students to use new digital tools and troubleshoot technology issues
Designer	6	.92	Accommodating diverse needs of students; designing real-world learning activities; fostering students' independent learning; creating innovative digital learning environments to maximize students' learning; personalizing learning experiences to meet individual learning needs
Facilitator	4	.90	Fostering a culture of learning with technology; Modeling and nurturing creativity; managing in digital platforms; and creating learning opportunities that challenge students to use a design process/computational thinking to solve problems
Analyst	5	.92	Providing alternative ways for students to demonstrate competency; collecting assessment data to monitor students' progress; communicating assessment data with stakeholders; designing and implementing formative and summative assessments for timely feedback and appropriate accommodations
Total	31		

DATA ANALYSIS

All the responses from the completed questionnaires were entered into an MS Excel spreadsheet. Data were then exported into SPSS software for further statistical analysis. First, to ensure the questionnaire's reliability, Cronbach's alpha was calculated to measure the internal consistency among items in each standard. Then, descriptive analyses were

conducted to describe the participants' characteristics and levels of ET competencies. One-way repeated measures of ANOVA were used to find a difference in the means across the seven standards of ET competencies for all participants. MANOVAs were used to examine the differences in ET competencies by the teacher preparation programs (i.e., multiple-subject, single-subject, or special education). For the effects of contributing factors to the participants' total ISTE competency level, factorial ANOVAs were used.

RESULTS

ET COMPETENCIES OF TEACHER CANDIDATES

The universities did not significantly affect the total ET competency level of teacher candidates. Therefore, all analyzes were performed on a total of 377 participants from both universities combined. On average, 35.5% ($n = 134$) of the respondents rated their ET competency level as somewhat experienced and knowledgeable (a score of 2), 30.8% ($n = 116$) as have an idea of what I need to work with (3), followed by 19.6% ($n = 74$) who rated their competency as not familiar with (1). Only 13.3% ($n = 50$) rated themselves as experienced, proficient, and knowledgeable (4) and 0.8% ($n = 3$) as integration of multiple tools at a high level of functionality (5). The mean score of the total ISTE competency level (ISTE), which is a composite mean score derived from all 31 items, was 2.88 ($SD = 0.93$). Figure 1 shows the means and the average response distributions for ISTE, as well as the response distributions of seven standards, along with their means. Fewer than 15% of respondents rated their ET competencies as a 4 or higher on all seven standards.

One-way repeated measures of analysis of variance (ANOVA) were conducted to find differences in the means among the seven standards. Mauchly's test indicated the assumption of sphericity was violated, $X^2(20) = 160.57$, $p < .001$; therefore, degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = 0.88$). The results showed that the means were significantly different across the standards, F (5.29, 1987.33) = 42.95, $p < .001$. As shown in Figure 1, in a post-hoc test using Bonferroni corrections, the participants scored significantly higher for Citizen ($M = 3.01$) than Leader ($M = 2.59$), Designer ($M = 2.90$), Facilitator ($M = 2.86$), and Analyst ($M = 2.86$). The participants' score in Leader was also significantly lower than the other standards.

ET COMPETENCIES BY TEACHER PREPARATION PROGRAMS

The participants had significantly different average scores for ISTE and Learner, Citizen, Collaborator, and Designer by their teacher preparation program type, $\Lambda = 0.93$, F (14, 688) = 1.85, $p = .029$ (See Figure 2). Subsequent univariate analyses with Bonferroni corrections were conducted on ISTE and all seven standards. Multiple-subject teacher candidates scored significantly higher than special education candidates on ISTE and the Citizen, Collaborator, and Designer standards. Single-subject teacher candidates did not differ significantly from the other groups. For Learner only, multiple-subject candidates had significantly higher scores than both single-subject and special education teacher candidates.
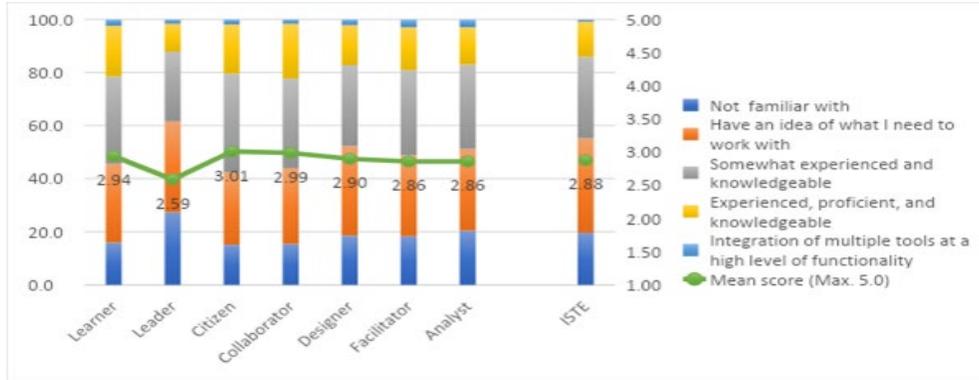
Figure 1. *Means and Responses Distributions of Seven Standards and the ISTE Competency*

Note. The Y-axis displays the distribution percentage for the five-point scale responses. Green closed circles indicate the mean scores for seven standards and overall competency. The ISTE competency level represents the average score across all 31 items from 377 respondents.
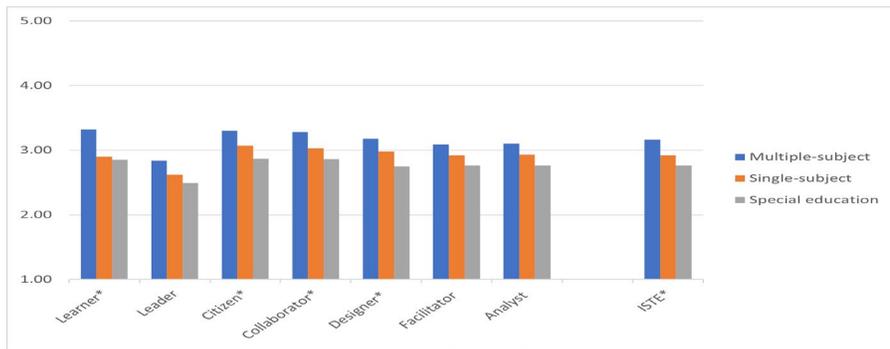

Figure 2. *Means of Seven Standards and the ISTE Competency by Teacher Preparation Programs*

Note. The Y-axis represents the means of seven standards and the overall ISTE competency, ranging from 1 to 5. An asterisk indicates significant differences in the means between the teacher preparation programs (i.e., Multiple-Subject, Single-Subject, and Special Education) at a p-value of .05.

Table 4. *Main Effects of Demographic- and Teaching-Related Variables on the Overall ET Competency*

		n	%	M	SD	F ratio	p
Gender		374				0.03	.853
	Female	266	71.1	2.88	0.96		
	Male	108	28.9	2.85	0.88		
Age		374				6.12	.002
	24 or younger	112	29.9	2.88_a	0.93		
	25-34	196	52.4	2.98_a	0.90		
	35 or older	66	17.6	2.54_b	0.92		
Current occupation		377				3.99	.013

Classroom teacher	77	20.4	2.94$_{ab}$	0.83		
Substitute teacher	89	23.6	2.89$_{ab}$	0.92		
Paraprofessional	53	14.1	3.28$_a$	0.84		
Other	158	41.9	2.71$_b$	0.98		
Currently teaching	376				0.00	.987
No	217	57.7	2.85	0.96		
Yes	159	42.3	2.92	0.88		
Team-teaching experience	360				3.16	.047
No	208	57.8	2.78$_b$	0.91		
Yes	152	42.2	3.07$_a$	0.92		

Note. Means with different subscripts differ at the p = .05 level by Bonferroni post-hoc tests.

CONTRIBUTING FACTORS TO THE TOTAL ISTE COMPETENCY LEVEL (ISTE)

The effects of the teacher candidates' demographic and teaching-related characteristics (i.e., gender, age, cohort, current occupation, the status of current teaching, and team-teaching experience) on their total ISTE competency level (ISTE) were investigated using an independent factorial ANOVA test. This test revealed significant main effects of these variables on ISTE, F (9, 343) = 3.47, p = .000. Table 4 shows the means and standard deviations of the participants' ISTE by their demographic and teaching-related variables.

Age, current occupation, and team-teaching experience were found to have a significant main effect on ISTE (F [2, 343] = 5.80; p = .003, F [3, 343] = 2.91, p = .013, and F [1, 343] = 3.28, p = .043, respectively). In the Bonferroni post-hoc tests, the mean of participants aged 35 or older (M = 2.54, SD = 0.92) was significantly lower than that of participants aged 25-34 (M =2.98 and SD = 0.90) and younger than 24 (M = 2.88, SD = 0.93). Paraprofessionals had a significantly higher mean ISTE (M = 3.28, SD = 0.84) than those who did not work in a classroom (M = 2.71, SD = 0.98) while no significant differences were found with other groups (i.e., substitute teachers and other).

Participants with team-teaching experience had a significantly higher score of ISTE (M = 3.07, SD = 0.92) than those without team-teaching experience (M = 2.78. SD = 0.91). To further analyze the relationship between team-teaching experience and other demographic and teaching-related variables, a series of chi-squares were conducted. Results showed that teacher candidates who were not teaching (31.3% of 201, $\chi^2(1)$ = 22.62, p = .000), in special education program (29.8% of 114, $\chi^2(2)$ = 10.04, p < .01), or with other jobs (34.7% of 144, $\chi2(3)$ = 15.06, p < .01) were more likely to have less experience in team-teaching. No other variables were found to be significantly associated with the team-teaching experience.

PERCEPTION OF TEACHER PREPARATION PROGRAM'S IMPACT

The participants were asked to report their primary source of ET skills and whether their current teacher preparation program had improved their ET skills. Of the 377 respondents, 32% (n = 121) reported they acquired their ET skills through self-taught, 26% (n = 98) reported they had acquired them through their previous schooling (e.g., high school or college), and 22.3% (n = 84) reported they had acquired them through their current teacher preparation program. The mean of the total ISTE competency level (ISTE) did not significantly differ depending on the participants' primary learning source for ET skills. When asked how much their current teacher preparation program had improved their ET

skills, 12.2% ($n = 46$) reported it had completely helped, 27.3% ($n = 103$) reported it had helped in some aspect, but not all, 35.5% ($n = 134$) reported it had helped only a little bit, and 24.1% ($n = 91$) reported it had not helped at all. The participants' ISTE was significantly impacted by their perceptions of the program's impact, F (3, 370) = 11.92, p < .001. The two groups, completely helped and in some aspects ($M = 3.36$, $SD = 0.79$; $M = 3.07$, $SD = 0.78$, respectively), had significantly higher means than the other groups, only a little bit and not at all ($M = 2.77$, $SD = 0.89$; $M = 2.55$, $SD = 0.99$, respectively).

Two-way factorial ANOVA was used to investigate the main effects of teacher candidates' perceptions of their program impact on ISTE, along with the factors of program type (i.e., multiple-subject, single-subject, and special education), age, current occupation, and team-teaching experience. The program impact had the largest main effect on ISTE, F (3, 314) = 6.21, p = .000, followed by age and the program type, respectively, F (2, 314) = 6.21, p = .002, F (2, 314) = 3.06, p = .048. There were no significant interaction effects between program impact and other contributing factors on ISTE. Figure 3 shows the main effects of teacher candidates' perceptions of their program impact and their age on ISTE without a significant interaction effect. Teacher candidates aged 35 and older had significantly lower ISTE than younger participants, but those who recognized the impact of the program on ET skills had significantly higher ISTE than those who did not. Likewise, as shown in Figure 4, all general (i.e., multiple and single-subject credential programs) and special education teacher candidates exhibited higher ISTE when recognizing the programs' impact on their ET skills.
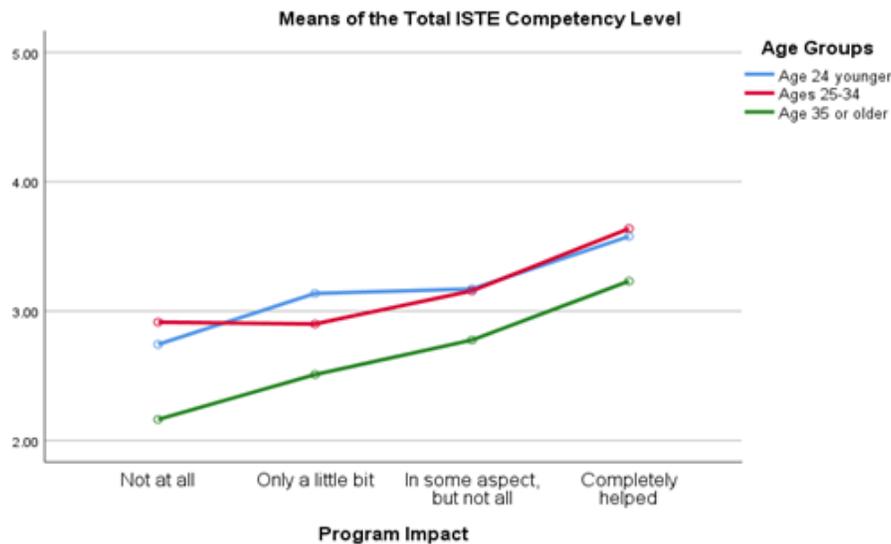

Figure 3. *Main Effects of Teacher Candidates' Perception of Their Program Impact and Age Groups on the Overall ISTE Competency Level*
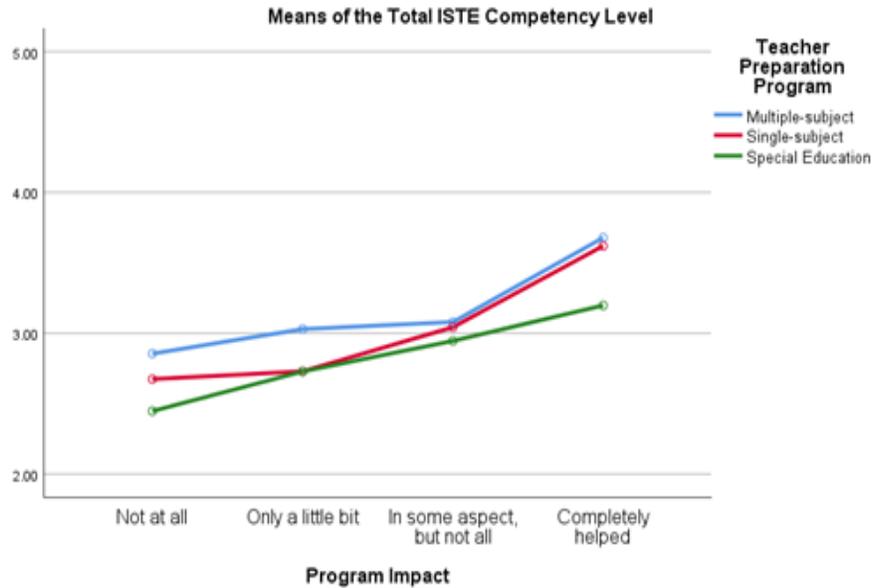
Figure 4. *Main Effects of Teacher Candidates' Perception of Their Program Impact and Types of Teacher Programs on the Total ISTE Competency Level*

DISCUSSIONS

The purposes of this study were to evaluate the ET competency status of teacher candidates as measured by the 2017 ISTE Standards for Educators and to explore contributing factors to their ET competency level, including their perceptions of the teacher preparation program impact.

ET COMPETENCIES OF TEACHER CANDIDATES

Overall, more than 67% of teacher candidates reported their ET competencies in the range of Have an idea of what I need to work with and Somewhat experienced and knowledgeable, with a mean score of 2.88 on a scale of 1-5. Based on the 2017 ISTE Standards for Educators, the participants' ET competencies were not at the proficient level yet but a little higher than the teacher candidates from Kimm et al. (2020) and Baek and Sung (2021). However, this competency level was relatively lower than that of in-service teachers, who reported fair levels of confidence in using technology (Gomez et al., 2022).

Per ET competencies across seven standards, the participants scored higher on average for Citizen and significantly lower average scores for Leader. The Citizen standard focuses on becoming digital citizens who can use technology to positively contribute to the digital world (Trust, 2018). This standard directly relates to the cultural norms and rules of the digital world, in which individuals exercise safe and responsible uses of digital media (ISTE, 2017). Gomez et al. (2022) reported that in-service teachers also have the highest level of confidence regarding the technology literacy & digital citizenship component. Although teacher candidates in our study scored higher on items of Citizen (e.g., data privacy and safe practices using digital tools and content), they still had lower scores on online interactions, digital identity, and building a safe digital culture. Teacher candidates are expected to strive to guide and lead by example to their students, developing and sustaining a culture of digital safety through the daily use of digital tools and media. They should promote and encourage responsible and ethical practices in order to foster a secure and safe digital environment. They should be fully aware that creating and maintaining an

inclusive and safe learning environment applies both online and offline (Commission on Teacher Credentialing, 2021). Accordingly, teacher educators should model the legal, ethical, and socially responsible use of technology for teaching and learning and provide opportunities for teacher candidates to design curricula following legal, ethical, and socially-responsible use of technology (Foulger et al., 2017).

The standard of Leader assesses whether educators take on leadership roles to support student empowerment and success, as well as improve teaching and learning. This standard focuses on utilizing technology to bridge the digital divide and empower all students as learners (ISTE, 2017; Trust, 2018). For example, the indicators directly measure the respondent's active participation in promoting improved technology accessibility for all students. Understandably, teacher candidates scored lower on those indicators since they are still working towards acquiring a teaching certificate and have limited chances to exemplify and guide their peers to support students' learning. In addition, equitable technology accessibility for all students necessitates "a robust and flexible learning infrastructure capable of supporting new types of engagement and providing ubiquitous access to the technology tools that enable students to create, design, and explore" (Office of Education Technology, 2017, p. 69).

As technology becomes more pervasive in P-12 education, conversation about equity in ET has centered around equitable access to technology-enhanced learning opportunities for traditionally underserved student populations (e.g., students of color or those with socio-economical disadvantages). However, students with disabilities who face barriers to access have often been ignored in the discourse on equity in ET (Goggin, 2017; Shaheen & Watulak, 2019). This seems to be due to the exclusive application of assistive technology (AT) for students with disabilities (Kimm et al., 2020; Shaheen & Watulak, 2019). With increasing access to universally designed technologies, such as Google Chromebooks with speech-to-text, text-to-speech, live captioning, and a multitude of accessibility features built into the system, schools have started to replace AT with these tools. However, schools cannot ensure that students with disabilities have adequate access to these technologies in the absence of systematic monitoring of their educational benefits (Wu, 2019). Moreover, lack of collaboration and disassociation between technology and special education departments often leads to inadequate support for students with disabilities (Shaheen & Watulack, 2019; Wu, 2019). The relatively low ET proficiency level of special education teacher candidates in our study indicates that collaboration between these two departments is more urgent than ever.

ET COMPETENCIES BY TEACHER PREPARATION PROGRAMS

Special education teacher candidates had significantly lower scores than multiple-subject teacher candidates for the total ISTE competency level (ISTE), as well as for Learner, Citizen, Collaborator, and Designer. This finding aligns with the previous studies that reported limited competencies in AT as well as instructional technology of special educators (Coleman et al., 2015; Okolo & Diedrich, 2014; Zhou et al., 2011). In contrast, Kimm et al. (2020) reported that special education teacher candidates exhibited higher levels of ET competency compared to single-subject teacher candidates. They suggested that this difference was due to the special education program's inclusion of an additional ET course and more comprehensive training in AT for the special education population. In our study, participants were drawn from six different programs across two universities in California, with only one program offering an additional ET course. Taking an additional ET course did not make a significant difference in the ISTE competency levels of teacher candidates in our study.

The California Commission on Teacher Credentialing (CTC) introduced updated standards for teacher preparation programs in 2015 and general education Teaching

Performance Expectations (TPEs) in 2016. These TPEs emphasize the use of technology to support diverse student populations and promote inclusive learning environments. Therefore, all general education teacher preparation programs were required to integrate the updated standards and TPEs starting in Fall 2017 (CTC, 2016). Next, the CTC introduced specialized TPEs for special education teacher candidates in 2018 that must be implemented in special education teacher preparation programs by Fall 2022 (CTC, 2021). Thus, during our data collection, multiple- and single-subject teacher candidates were expected to follow the updated TPEs, while special education teacher candidates were not yet obligated. The general education teacher candidates who were prepared under the newly implemented TPEs demonstrated higher ET competency levels than the special education candidates who were not. Although our research does not establish a direct causal link between the updated TPEs and the ET competency levels of teacher candidates, the disparity in ET competencies between general and special education teacher candidates can be examined within the framework of standards-based reform movements (McLeskey et al., 2017). The standards-aligned reforms in teacher education may have contributed positively to enhancing teacher candidates' ET competency levels, as measured by the ISTE Standards for Educators. This aligns with the new mandate that teacher preparation programs explicitly prepare future educators to meet ET standards (CTC, 2021; Office of Education Technology, 2017).

CONTRIBUTING FACTORS TO THE TOTAL ISTE COMPETENCY

The candidates' age, current occupation, and team-teaching experience among the teacher candidates' demographic and teaching-related characteristics significantly influenced their total ISTE competency level (ISTE). First, the candidates aged 35 and above had significantly lower ET competency levels compared to younger groups (24 or younger and 25-34). Recent studies report conflicting findings on the relationship between age and ET competencies (Kimm et al., 2020). Almisad (2020), Tondeur et al. (2018), and Michaeli et al. (2020) found no significant impact of age on ET competencies or the perception of meeting ISTE standards among teacher candidates and teachers. In contrast, Li et al. (2019) found that younger teachers were more inclined to integrate technology into their teaching. They suggest that age may play a more critical role in ET competency in studies with a wider age range and that younger educators demonstrate a more positive approach to technology use in education (Li et al., 2019). The younger participants who have been exposed to technology integrated in their education (List, 2019) are more like to have more positive attitudes toward using ET in teaching and learning (e.g., Technology Acceptance Model, Davis, 1989; Granić & Marangunić, 2019). In our study that has a wider range of age group, younger candidates may possess higher ET competencies.

Per the current job variable, paraprofessionals reported significantly higher ET competencies than any other occupation groups including their full-time teaching counterparts (e.g., intern or resident teachers). There are few studies that report paraprofessionals' ET competency level, we need to explore possible reasons for this group's significantly higher ET competency level. Full-time teachers have reported time constraints as a significant barrier to improve their ET skills (Jones et al., 2019) while paraprofessionals benefit more flexibility in terms of playing diverse roles in educational setting and collaborating with various professionals (Gimsby, 2023). For example, paraprofessionals are in charge of delivering technology-integrated interventions such as using augmentative and alternative communication system or video prompting (Brock & Anderson, 2021) which allows them more opportunities to engage with and enhance their ET skills. Furthermore, their motivation towards earning teacher certifications (Mason et al., 2021) may also fuel their competence in ET.

Team-teaching experience, a concept often interchangeably used with co-teaching, collaborative teaching, and cooperative teaching (Decuyper et al., 2023) was the last factor to influence the candidates' ET competencies. Candidates with team-teaching experience had significantly higher ET competency levels than those without. This supports earlier findings by Kimm et al. (2020). Collaborative environments are more likely to enhance digital literacy, a key component for effective technology use (List, 2019; van Laar et al., 2017). Thus, we can argue that candidates with more experience working in collaborative environments (i.e., team-teaching) may have higher ET competencies. After examining teacher candidates' team-teaching experiences more closely, we found that special education candidates and those not working in classrooms generally had less team-teaching experience. This discrepancy, particularly among special education candidates, may stem from two factors. Firstly, special education programs are divided into three emphases based on the student population served: mild-to-moderate disabilities, moderate-to-severe disabilities, or early childhood special education. While all emphases include collaboration courses and supervised fieldwork in general education settings, candidates focusing on moderate-to-severe disabilities often have fewer chances for team-teaching during their training. Secondly, since 2017, California's credentialing requirements have mandated 200 additional early fieldwork hours for general education candidates, a requirement extended to special education candidates in 2022 (Commission on Teacher Credentialing, 2016, 2021). This policy likely affords general education candidates more team-teaching opportunities. Baek and Sung (2021) observed that candidates with 8-10 fieldwork hours had significantly higher ET competencies than those with less, suggesting that increased early fieldwork hours can enhance ET competency.

In short, our findings suggest that younger, paraprofessionals, and those with team-teaching experience have significantly higher ET competency levels, indicating that teacher candidates should be provided with more opportunities to leverage educational technology in teaching and learning.

PERCEPTION OF TEACHER PREPARATION PROGRAM'S IMPACT

More than a third of teacher candidates acquired their current ET skills through self-taught methods, such as the Internet or YouTube, confirming that the majority of teacher candidates perceive their digital literacy skills as the acquisition of a set of necessary skills or competencies (List, 2019). Fewer than half of teacher candidates perceived that teacher preparation programs had a positive impact on their ET skills, which is consistent with previous studies (Baek & Sung, 2021; Kimm et al., 2020). Interestingly, the total ISTE competency level of teacher candidates was significantly affected by their perception of the program's effectiveness on their ET skills, not the source from which they acquired the skills. Teacher candidates who appreciated the program's contribution to ET skills had higher ISTE competency. This was consistent across age groups and program types. Thus, our findings suggest that the focus of teacher preparation programs should shift from merely acquiring ET skills to embedding these skills effectively in teaching practices to ensure these skills translate effectively to classroom practice. Crompton's (2023) review found that ISTE Standards for Educators directly contributed to K-12 student learning gains, underscoring the importance of integrating these standards throughout teacher preparation programs. Thus, teacher preparation programs should purposefully integrate the new ISTE Standards for Educators throughout their curricula, which will enable future teachers to not only acquire but also effectively apply ET skills in their professional practice, fostering continual development of their ET competencies even after completing their teacher preparation program (Baek & Sung, 2021; Commission on Teaching Credentialing, 2021; Kimm et al., 2020).

LIMITATIONS OF THE STUDY AND SUGGESTIONS FOR FURTHER RESEARCH

We implemented a single cross-sectional survey method in this study. This method has limitations in examining the development of teacher candidates' ET competencies throughout their preparation programs. A longitudinal approach is needed to track the trajectory of ET competencies before and after teacher education programs. The assessments should include initial levels of ET competencies, interim development, and final competencies upon completion of the program. Diversifying assessment methods by including candidates' performance data in relation to learning outcomes, interviews, observation of teaching practices can help triangulate the data (Creswell & Creswell, 2018) and provide a more comprehensive picture of the teacher candidates' experiences and their perceptions regarding ET competencies.

IMPLICATIONS FOR TEACHER PREPARATION PROGRAMS

Our findings suggest that teacher education programs should make a shift from mainly focusing on candidates' acquisition of ET skills to preparing future educators to effectively integrate ET into their teaching and learning through more hands-on practice in early fieldwork and collaborative teaching experiences (Baek & Sung, 2021; Kimm et al., 2020; Watulak, 2018). To address the technology accessibility gap between students with disabilities and the general population, it is important to adopt the Universal Design for Learning (UDL) principles and promote collaboration between special education and educational technology disciplines in teacher education programs (Shaheen & Watulak, 2019; Wu, 2019). This interdisciplinary approach will help future educators create inclusive learning environments and meet the needs of all students, especially those with disabilities (Kaczorowski et al., 2023). Mrstik et al. (2021) report how a teacher preparation program was updated to enhance online teaching, technology integration, and the use of AT. This led to its graduates being recognized as leaders in ET within their schools, often demonstrating technology-focused lessons. This study highlights the need to foster leadership in technology among teacher candidates by providing numerous opportunities to spearhead tech initiatives in educational and community settings. Therefore, teacher preparation programs should focus on developing the competencies required for teacher candidates to integrate technology into teaching ethically and effectively, positioning them as future leader in technology-enriched learning environment (International Society for Technology in Education, 2017; Office of Education Technology, 2017).

It is the development of both technical and pedagogical competencies that form a basis for effective technology integration in education (Compton, 2023). Continuous professional development to maintain and advance these competencies (Gomez et al., 2022) and standards-based assessment tools (Vucaj, 2022) are the fundamental frames that give opportunities to reassess and improve technology integration skills. Technology integration is complex, and support and development must be ongoing throughout teachers' careers. Effective technology integration measurably improves learning outcomes, a fact that further validates these competencies as significant in today's education (Compton, 2023). This holistic approach to technology integration, paralleled by continuous development and assessment both for pre-service and in-service educators, contributes much to the improvement of educational outcomes and effectiveness by general and special education teachers alike.

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