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Development and Validation of the Technology Integration Confidence Scale (TIC-S) Version 3 Instrument for Technology Use and Integration

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Abstract

This instrument development and validation study examined urban K-12 teachers' self-efficacy in performing technology integration tasks, framed through the lens of Bandura's (1997) concept of self-efficacy, which is the belief in one's capability to execute specific actions. The Technology Integration Confidence Scale (TIC-S) version 3 was developed and refined through a pretest, pilot study, and final quantitative investigation to evaluate its psychometric properties. Following pretesting, the instrument's subscale structure was realigned based on both theoretical foundations and statistical insights. Grounded in the 2017 ISTE Standards for Educators and adapted from Browne's (2007) TIC-S version 2, the revised survey was administered online to 327 urban Catholic school teachers in Southern California. Participants self-reported their confidence in performing key technology-integrated pedagogical tasks. Statistical procedures, including Cronbach's alpha and exploratory factor analysis (EFA) using principal component analysis (PCA) with oblique rotation, confirmed the instrument's reliability and validity. The TIC-S version 3 is both a psychometrically sound research instrument and a practical diagnostic tool for assessing teachers' readiness to integrate technology into instruction. For practice, results highlight its utility in guiding targeted professional development and supporting teachers in adapting to emerging technologies, including AI-enhanced learning environments. For research, the study supports further validation across diverse contexts, and recommends longitudinal and mixed-methods investigations to examine changes in teacher self-efficacy and its relationship to classroom practice. Overall, TIC-S version 3 provides a meaningful framework for advancing effective technology integration in K–12 education and is affirmed as a tool for future research related to techno-pedagogical applications in education.

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Introduction

Technology presents new possibilities for living and learning (Paus-Hasebrink et al., 2010) and has steadily become more immersive and pervasive in our lives (Clark & Mayer, 2016; Kay, 2006). New media have had a growing impact on most aspects of human endeavor, including education, where the availability of technology in schools has significantly increased over the past decade (Howard, 2013; Tamim et al., 2011). The COVID-19 pandemic further accelerated the adoption and use of technological resources to support remote and hybrid/blended learning environments, helping meet students' continuous learning needs. Digital devices such as laptops, tablets, and smartphones have expanded opportunities for effective teaching and learning both in classrooms and remotely (Clark & Mayer, 2016; Sadaf et al., 2016). These 21st-century technologies have enabled greater mobility and connectivity within and beyond the learning community.

As these devices and platforms continue to evolve, their instructional potential is limited only by the extent to which teachers can effectively integrate them into classroom, online/remote, and hybrid/blended learning settings. Teachers today—whether in public, private, or charter schools—are increasingly expected to design personalized learning experiences rather than rely on the traditional "one-size-fits-all" approach (An & Reigeluth, 2012; Deye, 2015; Tomlinson, 2017). Technology integration supports this pedagogical shift by enabling more customized instructional delivery and student engagement. However, this shift raises an important question: Are teachers confident in their ability to integrate technology effectively? There is a pressing need to reliably assess teachers' confidence levels in this area. This need underpins the rationale for developing and validating the Technology Integration Confidence Scale (TIC-S) Version 3. The instrument aims to measure key tasks associated with effective technology integration in contemporary educational contexts.

Literature Review: Recent Trends in Teacher Self-Efficacy for Technology Integration

Conceptual Foundations of Teacher Self-Efficacy in Technology Integration

Bandura's (1997) theory of self-efficacy—defined as individuals' belief in their capability to execute specific actions—provides the central theoretical lens for this validation study. This approach, contextually, frames teachers' confidence in their ability to use and integrate technology. Recent empirical work in educational technology, including the emerging field of AI-EdTech (Guo et al., 2024), continues to apply this framework to technology-infused pedagogies, thereby illustrating how self-efficacy shapes both instructional quality and innovation.

Relationship between Self-Efficacy and TPACK/TIC Constructs

Multiple studies in the past five years reinforce the positive relationship between teacher self-efficacy and models such as TPACK (Technological Pedagogical Content Knowledge) and TIC (Technology Integration Confidence) constructs. A meta-analysis of 7,777 teachers confirmed a strong positive association between technology integration self-efficacy and TPACK ($r = 0.607$, $P < 0.001$), which indicates that greater confidence in technology use aligns with more effective integration of pedagogy, content, and technology (Zeng et al., 2022). Context-specific research echoes this pattern as well; for example, in Southern California, self-efficacy measured through the TIC-S predicted higher engagement in technology-infused instructional tasks (Gomez et al., 2022). In Qatar, instructional self-efficacy in technology was linked to STEM efficacy, with variation across demographics and contexts (Sellami et al., 2024).

These findings and trends in the literature affirm that Bandura’s (1997) self-efficacy theory remains a vital framework for understanding how teachers perceive their competence in integrating technology. Technological pedagogical self-efficacy—defined as confidence in using technology to enhance pedagogy—has been shown to drive instructional transformation. Bakar et al.’s (2018) systematic review found that while factors such as perceived ease of use and usefulness play a role, teacher self-efficacy is central to implementation and occupies a decisive role in technology integration outcomes.

Professional Development and Self-Efficacy Outcomes

Recent research highlights the pivotal role of sustained, well-designed professional development (PD) in strengthening teachers’ self-efficacy, i.e., their belief in their ability to successfully teach, manage classrooms, and use tools like technology. A systematic review of PD programs (2020-2024) found that sustained, collaborative, hands-on digital training significantly improved teachers’ attitudes, confidence, and competencies in technology integration (Amemasor et al., 2025). This finding about PD programs from the last five years aligns with self-efficacy theory, which posits that repeated mastery experiences and social modeling enhance confidence (Bandura, 1997).

This result is further affirmed by a meta-analysis of STEM teacher PD, which reported that professional development has a substantial effect size ($g = 0.64$, $p < .01$) for improving self-efficacy (Zhou et al., 2023). For this reason, studies in urban K-12 contexts emphasize that repeated, context-specific PD, rather than one-off workshops, builds enduring techno-pedagogical competence (Gomez et al., 2022). Collectively, these findings confirm that ongoing, situated training is a key driver of integration efficacy.

Technology Evolution: AI, Trust, and Teacher Confidence

The rapid rise of artificial intelligence (AI) in education introduces both opportunities and challenges for teacher confidence and successful implementation (Guo et al., 2024). Research across six countries found that self-efficacy in AI-EdTech significantly predicted trust, perceived benefits, and reduced concerns (Viberg et al., 2023). In Sri Lanka, however, emotional and psychological factors outweighed mastery experiences as determinants of AI self-efficacy (Rajapakse et al., 2024), thereby, underscoring the need for PD that addresses affective as well as technical dimensions (Nazaretsky et al., 2022).

Despite increasing AI adoption in K-12 contexts, research on teacher trust and attitudes toward AI-powered tools remains scarce (Nazaretsky et al., 2022). Yet, trust emerges as a pivotal factor, often constrained by misconceptions or workload concerns (Cukurova et al., 2023). Studies show that beyond technical competence, self-efficacy in evaluating and adapting AI outputs is critical. For instance, U.S. surveys reveal that many teachers use generative AI, such as ChatGPT and MagicSchool, for lesson planning, citing time savings and reduced burnout, but still rely on professional judgment to vet outputs (Johnson, 2023; Gecker, 2025). Accordingly, the growing adoption of AI in schools highlights its "double-edged" nature. It offers benefits such as enhanced lesson planning, personalization, and accessibility, while also raising concerns about potential misuse, threats to academic integrity, and the ongoing need for staff training and trust-building (Ofgang, 2025; Sokoloff, 2025).

Contextual Drivers and Influences on Self-Efficacy and Emerging Technologies

Teacher self-efficacy develops within a web of structural, emotional, and contextual factors, including institutional support, access to technology, and program culture. In teacher preparation programs, integration expectations, equitable access, and mentor modeling are essential for building technological self-efficacy (Williams et al., 2023). A UTAUT/UTAUT2-based review confirmed that performance expectancy and social influence are key predictors of technology adoption behaviors (Bakar et al., 2018). Furthermore, a study by Choi et al. (2023) found that teachers' willingness to adopt and integrate technology, including AI, in their teaching is crucial if students are to benefit from the potential advantages, like differentiated instruction and real-time feedback, proffered by emerging technologies.

Through an analysis of teachers' self-efficacy beliefs regarding remote teaching, psychological well-being, and apprehensions during the COVID-19 pandemic in Belize, Quiroz et al. (2024) found that teachers' self-efficacy was negatively related to, or inversely connected with, their psychological well-being and apprehensions (worries, anxieties, or concerns). In other words, teachers with greater confidence in their teaching abilities tended to experience less stress, anxiety, and psychological strain, whereas those with lower self-efficacy were more likely to struggle with well-being and worry. Emerging evidence also links self-efficacy to emotional regulation and resilience. Teachers with higher self-efficacy report better emotional regulation and lower digital burnout in online instruction (Yang & Du, 2024). These findings suggest that self-efficacy in technology integration is as much psychological as it is technical.

Self-Efficacy During Emergency Remote Teaching

The COVID-19 pandemic, which caused a pivot to remote learning, offered a natural stress test for technology self-efficacy. A study by Cardullo, Wang, Burton, and Dong (2021), which examined factors from the extended Technology Acceptance Model (TAM) in relation to teachers' self-efficacy in remote teaching during the pandemic, found that teachers' self-efficacy influences how they integrate technology into their instruction. Comparative studies between U.S. and Spanish teachers found differences in digital tool self-efficacy shaped by nationality, training, and support (García-Martín et al., 2023). Notably, frequent technology use prior to the pandemic (Gomez et al., 2022; Rabaglietti et al., 2021), as well as during the pandemic, did not guarantee effective integration (García-Martín, Rico, & García-Martín, 2023). These findings highlight the need for pedagogically grounded, confidence-building experiences rather than technology use alone to improve teachers' instructional practice and better support student learning (Cardullo et al., 2021; Gomez et al., 2022; Hughes, 2005).

Comparable Survey Instruments and Their Applications

Several instruments have been developed to assess teachers' technology-related self-efficacy and integration practices. The Technology Integration Self-Efficacy Scale (Wang et al., 2004) evaluates educators' confidence in using digital tools for instruction through the emphasis on general computer proficiency. Similarly, the Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010) measures teachers' ability to design technology-enhanced learning experiences, while the Teachers' Sense of Efficacy for Technology Integration Scale (Koh & Frick, 2009) assesses educators' beliefs in technology's capacity to elevate instructional outcomes. These instruments, though foundational, predate the 2017 ISTE Standards for Educators and thus may not encompass evolving dimensions such as digital citizenship, equitable access, and computational thinking. The TIC-S version 3 fills this gap by aligning its constructs with the updated ISTE framework while retaining Bandura's (1997) self-efficacy foundation. Moreover, TIC-S version 3 is tailored specifically for K-12 urban educators, which makes it particularly sensitive to their unique pedagogical contexts.

Building on earlier measures, emerging research in contemporary literature highlights the development of more domain-specific instruments. Guo, Shi, and Zhai (2024) introduced the Teachers' Acceptance of Artificial Intelligence in Education (TAAI) scale, which includes dimensions such as perceived usefulness, ease of use, behavioral intention, self-efficacy, and anxiety (all sub-dimensional Cronbach's alpha values > .76). The TAAI underwent confirmatory factor analysis (CFA) and achieved strong reliability via Cronbach's alpha (α = .92). Following this trend, Chiu et al. (2025) developed and validated the Teacher AI Competence Self-Efficacy (TAICS) scale through a Delphi method and CFA, confirming its reliability and utility across multiple dimensions of AI-integrated pedagogy (all sub-dimensional Cronbach's alpha values > .87).

Together, these newer instruments illustrate a growing emphasis on assessing technology-related confidence in light of emerging technologies like AI. The TIC-S version 3 aligns with this research trend, and offers a comprehensive measure across traditional and emerging domains of technology integration. Its validation through exploratory factor analysis (EFA) with PCA and oblique rotation enables empirical discovery of factors while respecting inter-item correlations. This approach is effective for uncovering the underlying structure of confidence-based constructs.

Synthesis and Implications for TIC-S version 3 Development

Across the literature, teacher confidence emerges as a pivotal determinant of effective technology integration. This evidence underpins the development of the Technology Integration Confidence Scale (TIC-S) version 3, designed with a multidimensional structure encompassing usage/application, technology-infused learning, digital citizenship, and assessment. The literature suggests:

- Self-efficacy's robust link with TPACK/TIC constructs underscores the importance of measuring confidence across nuanced domains.
- Sustained, context-rich PD enhances self-efficacy, supporting the need for an instrument that can track growth over time.

- AI-related studies reveal that trust and affective factors are integral to confidence in emerging technologies.
- Institutional and infrastructural contexts shape self-efficacy, implying that TIC-S results can guide systemic interventions.
- Variability in self-efficacy during emergency remote teaching supports the use of TIC-S as a diagnostic tool in instructional shifts.
- Reflecting the broader trend toward domain-specific, psychometrically robust instruments, TIC-S version 3 offers a comprehensive measure of technology integration anchored in the 2017 ISTE Standards.
- Validation through EFA with PCA and oblique rotation allows TIC-S version 3 to capture flexible factor structures while honoring the inter-factor correlations inherent in technology self-efficacy constructs.

Taken together, these findings and trends affirm the need for a validated, reliable measure, such as TIC-S version 3. One that can assess teacher confidence across diverse technological and pedagogical contexts, while guiding both research and professional development.

Background

Techno-pedagogical competence, according to Seifert (2019), involves those skills needed to use technology for pedagogical reasons and the ability to integrate technology into teaching. Such a competence encompasses a broad range of skills across various domains that support the effective use and integration of technology in education (Thakur, 2015). Successful integration depends not only on how technology is deployed in the classroom but also on the pedagogical model that underpins the initiative (Muir et al., 2004). The former is shaped by factors such as teachers' beliefs, social dynamics, institutional culture, and their self-efficacy and confidence in using and integrating technology (Straub, 2009; Windschitl & Sahl, 2002). The latter—technological-pedagogical models that support integration—includes frameworks such as Mishra and Koehler's (2006) TPACK (Technological Pedagogical and Content Knowledge), Puentedura's (2006) SAMR (Substitution, Augmentation, Modification, Redefinition) model, and Kimmons' (2012) PICRAT (Passive, Interacting, Creating; Replacement, Amplification, Transformation) matrix, among others.

While these models provide normative descriptions of what it means to be a tech-savvy teacher, they do not offer practical tools for applying or directly evaluating techno-pedagogical competencies (Harris, 2019). In other words, they fail to identify the essential characteristics teachers must demonstrate in daily practice or specify measurable areas for improvement to become proficient in technology integration (Harris, 2019). Therefore, there is a need for an instrument that can serve as a practical resource for teachers, coaches, and school leaders to assess and support effective technology integration.

The current instrument—Technology Integration Confidence Scale (TIC-S), version 3—was pre-tested and pilot-studied to assess teachers' technological efficacy and measure core tasks associated with effective integration. These tasks—namely, technology usage, technology application, technology-infused learning, digital literacy and citizenship, and technology-supported assessment—are designed to deepen instructional practice, promote peer collaboration, challenge traditional approaches, and prepare students to take ownership of their learning. This instrument inherently considers the attitudes, behaviors, and practices of educators in using technology for teaching and learning. Aligned with the seven benchmarks of the third and current iteration of the International Society for Technology in Education (ISTE) Standards for Educators (2017), and based on Browne's (2007) TIC-S version 2, it serves as both a self-assessment tool and a professional development roadmap. Educational technology coaches can use it to guide support efforts, while school leaders may use the data to assess teachers' confidence and competence in integrating technology, thus gaining insight into the techno-pedagogical strengths and needs of their teaching faculty.

Purpose of Study

Teacher technology self-efficacy should be considered a crucial factor in the learning process, as effective teaching occurs when instructional methods are meaningful, relevant, and capable of adequately supporting the demands of 21st-century learning (Brown, 2012). While teachers may have access to technological tools, such as mobile devices, this exposure does not necessarily imply they possess the knowledge or skills to effectively integrate technology into their teaching practices to enhance learning (Clark & Mayer, 2016; Koehler & Mishra, 2009). As Ertmer and Ottenbreit-Leftwich (2010) noted, the most effective instructional methods depend on a teacher's prior pedagogical training (e.g., whether they are trained to inform or to perform) and their repertoire of technological skills (e.g., familiarity with a device or application).

The best predictor of a teacher's ability and willingness to engage learners through innovative 21st-century instruction is their self-efficacy regarding technology integration (Wozney et al., 2006). This self-efficacy is influenced by the teacher's confidence, which stems from relevant training or experience that enables them to effectively integrate new technologies into the classroom and across the curriculum.

Further research on technology integration suggests that teachers are more likely to implement technology and pedagogical practices that align with their beliefs about technology (Ertmer et al., 2012). As Ertmer and colleagues (2012) pointed out, a teacher's belief in the efficacy of technology integration is one of the most significant factors influencing their actual implementation of these practices in the classroom. Understanding this predictive factor is essential for successful technology integration, particularly in K-12 classrooms and in online or remote teaching environments.

Given the current emphasis on innovative learning to prepare students for success in the 21st century, it is critical to focus on teachers' technology self-efficacy, as it affects not only their skills but also their willingness to use and implement technology effectively. Therefore, this study aimed to validate an instrument (TIC-S version 3) that previous research (including pretesting and pilot studies) has shown to reliably measure teachers' confidence levels in performing technology integration tasks in both K-12 classroom settings and remote learning environments. This validation was conducted within the framework of self-efficacy and was evaluated against the ISTE Standards for Educators (2017) and Browne's (2007) TIC-S version 2.

Research Questions

To accomplish the purpose of this study, the following research questions were explored:

1. Is the TIC-S version 3 reliable, both at the subscale levels and the overall scale?
2. Does the TIC-S version 3 have construct validity, in that, does the hypothesized factor structure fit the data well?

Theoretical Framework

The goal of the TIC-S version 3 is to serve as a rigorously developed self-efficacy scale aligned with the ISTE Standards for Educators (2017). Self-efficacy, as applied in the development of this survey instrument, is similar to the everyday concept of confidence. It refers to an individual's belief in their ability to perform a specific task or to achieve a particular outcome or level of mastery (Bandura, 1997; Denzine et al., 2005). In this context, self-efficacy specifically concerns an individual's confidence in using technology (Bandura, 1997) and is both task-specific and task-dependent (Artino, 2012). For example, in the classroom setting, self-efficacy relates to a teacher's confidence in integrating digital tools, such as Web 2.0 technologies, into lessons (action), as well as facilitating collaborative, student-centered learning using appropriate digital tools (attainment).

Instructional decision-making is a core responsibility of teachers and requires a strong sense of self-efficacy. Therefore, the tasks represented in the subscales of TIC-S version 3 (see Table 2) are designed to deepen instructional practice, promote peer collaboration, encourage teachers to rethink traditional methods, and prepare students to take an active role in their own learning. Aligned with the ISTE Standards for Educators (2017), TIC-S version 3 specifically measures teachers' self-efficacy in performing technology-related pedagogical tasks. The primary goal of this quantitative investigation is to validate TIC-S version 3 as a research instrument to assess teachers' confidence in integrating technology and to confirm the instrument's five essential subscales of technology integration—namely, technology usage, technology application, technology-infused learning, technology literacy and digital citizenship, and technology-supported assessment—as core measures of techno-pedagogical competence.

Rationale for Study

The TIC-S version 3 survey instrument, whose subscales were realigned after pretesting and further tested in a pilot study, is both theoretically and statistically sound. The realignment, which reduced the number of subscales, allows for a more balanced distribution of items across subscales, as suggested by the statistical model. More importantly, this realignment sharpens the focus on the role of technology in education, emphasizing technology use and application, as well as other key concerns such as Technology Literacy and Digital Citizenship. While the seven aspects of the ISTE Standards for Educators (2017) include these areas, they address them in a more general sense. The ISTE Standards focus more broadly on the educator's role in 21st-century education, where technology is expected to be integral to teaching and learning (see Table 1).

The pilot-tested TIC-S version 3, with its five realigned subscales, examined technology usage and explored technology integration in a more targeted manner. Therefore, the re-tested TIC-S version 3 is intended to measure teachers' self-efficacy in performing technology-pedagogical tasks related to technology integration, which ultimately aims to help students become empowered learners.

The seven benchmarks or subscales of the ISTE Standards for Educators are briefly explained in Table 1.

Table 1. Explanation of the Benchmarks of ISTE Standards for Educators

Benchmarks	**Explanations**
Learner	This category measures educators' comfort level in "continually improving their practice by learning from and with others, and exploring proven and promising practices that leverage technology to improve student learning" (ISTE, 2017).
Leader	This category measures educators' comfort level in "seeking out opportunities for leadership to support student empowerment and success, and to improve teaching and learning" (ISTE, 2017).
Citizen	This category measures educators' comfort level in "inspiring students to positively contribute to and responsibly participate in the digital world" (ISTE, 2017).
Collaborator	This category measures educators' comfort level in "dedicating time to collaborate with both colleagues and students to improve practice, discover and share resources and ideas, and solve problems" (ISTE, 2017).
Designer	This category measures educators' comfort level in "designing authentic, learner-driven activities and environments that recognize and accommodate learner variability" (ISTE, 2017).
Facilitator	This category measures educators' comfort level in "facilitating learning with technology to support student achievement of the ISTE Standards for Students" (ISTE, 2017).
Analyst	This category measures educators' comfort level in "understanding and using data to drive their instruction and support students in achieving their learning goals" (ISTE, 2017).

Development of TIC-S version 3 – Pilot Studies

The development of the Technology Integration Confidence Scale (TIC-S) version 3 began with the construction of survey items aligned to the ISTE Standards for Educators (2017), focusing on teachers' self-efficacy in technology integration. Initial items were reviewed for clarity, relevance, and content overlap, and then validated by a panel of experts in educational technology and statistics. This process resulted in a 34-item instrument mapped to the seven ISTE standards.

Pilot study one involved pretesting the first draft of the TIC-S with 118 urban K-12 teachers from Southern California Catholic schools, yielding 97 usable responses. The initial analysis indicated the need to realign the instrument both theoretically and statistically. The reliability analysis resulted in a Cronbach's alpha coefficient of .985 for the 34-item TIC-S version 3, which is a very high reliability (the threshold is >= 0.8; >= 0.75 is marginally acceptable; Nunnally, 1978). Although the ISTE standards comprise seven benchmarks, the data suggested a better model with fewer components. As a result, the survey was refined to five components and reduced to 25 items, balancing item distribution across components and focusing more specifically on technology usage, application, literacy, and assessment.

The purpose of pilot study two was to further validate the revised 25-item TIC-S version 3, examining its reliability and construct validity as a self-efficacy measure aligned to the ISTE Standards for Educators (2017). Self-efficacy, conceptualized as teachers' confidence in integrating technology, underpinned the development of this instrument. The TIC-S version 3 aimed to predict teachers' willingness and capability to integrate digital tools effectively into their instruction.

For pilot study two, a quantitative survey methodology was employed. Using a random sample, the TIC-S version 3 was distributed online to K-12 teachers in urban Catholic schools in Southern California. Out of 111 responses, 68 completed surveys were retained for analysis. To perform the validation of the TIC-S version 3, a series of analyses were conducted. Item analysis was conducted using Critical Ratio (Independent Samples t-test) test and item-total correlations (Pearson's *r*).

Item discrimination was conducted using Critical Ratio, comparing the upper and lower 27% of respondents on each survey item. The test results for each item were significant ($p < .001$), therefore, we concluded that each item had enough power to discriminate upper and lower groups. Items were also assessed using item-total correlations to ensure that each item was meaningfully related to the overall instrument score. Pearson's *r* correlation coefficient test was computed to generate item-total correlations to compare each item on the instrument with the total composite score. The results revealed that all items and total score correlation coefficients were larger than the threshold of 0.5 coefficient. Therefore, all items on the instrument passed the two tests for item analysis and appeared to be functioning well.

Cronbach's alpha reliability coefficient was computed to examine the instrument's internal reliability. The results showed the reliability of the entire instrument was over 0.9, indicating excellent reliability. The results also show that it was not worthwhile to delete any of the items since doing so would not increase the reliability beyond the already high coefficient of .977. The results of the reliability analysis for the 5 components were greater than the threshold of .08, demonstrating very good reliability. Thus, both Cronbach's alphas for the overall scale and the sub-dimensions were above the minimal acceptable value of 0.80 for well-designed scales (Nunnally, 1978).

Exploratory factor analysis (EFA) was performed to investigate the factor structure underlying responses to the 25-item TIC-S version 3. EFA was employed to determine: "(a) how many latent factors underlie responses to the scale, (b) which items are measuring each factor, (c) what substantive label should be given to each factor, and (d) the nature of the correlations between the factors" (Hatcher, 2013, p. 406). First, EFA using Principal Component Analysis (PCA) with Oblique rotations and setting the number of factors to 5 was employed. The results revealed that these 5 components extracted explained up to 81.16% of total variances. Based on the Pattern Matrix, the 5 components extracted did not match the components as designed on the scale. Thus, a subsequent

EFA was conducted using the eigenvalue approach.

EFA using PCA with Oblique rotations and eigenvalues greater than 1 as the threshold to extract a factor was employed. Using the threshold as initial eigenvalue > 1, three components passed the threshold. These three components explained up to 74.35% of total variances. Since these three components did not match the design of the instrument, a subsequent EFA specifying the extraction of only one component was conducted to verify if the instrument is only measuring the one overarching construct of Technology Integration Confidence.

The results of the EFA testing whether the instrument is only measuring the one overarching construct of Technology Integration Confidence, revealed that with 1 component extracted, 65.35% of respondents' total variances toward the target construct was explained. This result is adequate, as ideally at least 50% of the variances should be explained. Hence, using the statistical techniques of item analysis and instrument validation, the analyses performed confirmed the instrument's reliability and validity, thereby, affirming its usage for future studies.

The significance of the current study lies in the retesting of the TIC-S version 3, which was pilot-tested and aligned to the International Society for Technology in Education (ISTE) Standards for Educators (2017). After reconfiguring the components and reducing the number of items based on theoretical and statistical measures, the pilot study statistically confirmed the items to be included in the TIC-S version 3 instrument (see Table 2).

Table 2. TIC-S version 3 Categorical Items per Component (C) as Re-aligned

	The ISTE Standards for Educators	**C1**	**C2**	**C3**	**C4**	**C5**	# of TIC-S Items (in new TIC-S v3)
1.	Learner	1 6		13 14 15 16 17		22 23	9
2.	Leader	2 3					2
3.	Citizen				18 19 20 21		4
4.	Collaborator	4 5				24	3
5.	Designer	7	8 9				3
6.	Facilitator		10 11				2
7.	Analyst		12			25	2

This third evaluation of the TIC-S version 3 aimed to affirm the tool's utility in measuring a teacher's self-efficacy in integrating technology. Additionally, this study sought to further confirm the reliability of TIC-S version 3 as a predictor of a teacher's willingness and ability to implement technology in ways that align with the content being taught. The following subscales of the instrument are explained below:

Technology Usage (C1)

The Technology Usage subscale assesses teachers' confidence in using and modeling technological devices and digital tools to support student learning. Teachers are expected to facilitate effective lessons using these tools. Those who are confident in their abilities can handle the logistics of operating technological devices and utilize them to present information and facilitate learning. Furthermore, they are able to model the use of these devices for students through demonstrations or step-by-step instructions.

Technology Application (C2)

The Technology Application subscale measures teachers' confidence in integrating technological devices into lessons and providing opportunities for students to apply digital tools as part of the instructional process. Teachers are tasked with facilitating effective, technology-supported lessons that include meaningful, real-world applications. Those who are confident in this area will seamlessly incorporate technological devices and digital tools/Web applications into lessons, both for instructional purposes and student learning applications, without requiring last-minute troubleshooting. Teachers who excel in this area can also offer extended learning opportunities that enhance student engagement and understanding.

Technology-infused Learning (C3)

The Technology-infused Learning subscale evaluates teachers' confidence in fostering student-centered learning through the effective use of technology. Teachers are encouraged to move away from traditional "one-size-fits-all" teaching approaches in favor of constructivist, student-centered learning experiences. Technological devices and digital tools/Web applications facilitate this shift by enabling collaborative and cooperative learning. Teachers who are confident in this domain can personalize, customize, and differentiate learning experiences for students using technology.

Technology Literacy & Digital Citizenship (C4)

The Technology Literacy and Digital Citizenship subscale explores teachers' confidence in using technology to communicate information and enhance the learning process, as well as their understanding of the skills students need to use technology appropriately. Before students can effectively use technology to learn, they must understand its language and the ethical considerations that come with digital engagement. This includes both appropriate online behavior and the nuances of digital citizenship. Teachers who are confident in this area are capable of modeling and conveying appropriate digital interactions and behaviors to students while teaching the necessary skills to navigate technology responsibly.

Technology-supported Assessment (C5)

The Technology-supported Assessment subscale examines teachers' confidence in creating environments where technology is integrated to provide meaningful assessments and feedback. Teachers are expected to support student learning through timely, relevant feedback. Formative assessments, facilitated through technology, enable teachers to monitor progress and address misconceptions in real-time. Teachers who are confident in this area can effectively use technology to offer immediate, constructive feedback that supports students during their learning processes.

These five subscales collectively assess teachers' readiness and preparedness to integrate technology effectively into their teaching practices. The pilot studies provided evidence that TIC-S version 3 is a reliable and valid measure of teachers' technology integration self-efficacy. The realigned five-component structure aligns conceptually with the ISTE Standards while focusing specifically on measurable technology integration practices. The TIC-S version 3 has been found to be a valuable tool for assessing teachers' confidence in using technology and predicting their likelihood of adopting technology in instructional settings. Further validation, however, with larger and more diverse samples was recommended. Hence, this third investigation is a continuation of prior efforts to further evaluate the TIC-S version 3 as a tool for measuring the factors that contribute to a teacher's effectiveness in using and integrating technology.

Methodology

This quantitative study aimed to validate the Technology Integration Confidence Scale (TIC-S) version 3, an instrument that was previously pre-tested and pilot-tested to measure tasks associated with effective technology integration. TIC-S version 3, which consists of five subscales, is aligned with the seven benchmarks of the third and current iteration of the ISTE Standards for Educators (2017; see Table 1) and builds upon Browne's (2007) TIC-S version 2.

Specifically, this study sought to validate the TIC-S version 3 instrument within the theoretical framework of self-efficacy. An online survey consisting of 25 Likert-type scale items was administered, in which participants self-reported their confidence in performing specific technology integration tasks. The collected data were subsequently analyzed using instrument validation techniques to assess the reliability and validity of the instrument. The following section provides a detailed description of the methodology employed in this validation study.

Setting

This investigation was conducted using data from teachers across multiple urban Catholic K-12 schools in Southern California. Catholic schools, united by their shared belief in Catholicism and governed by a hierarchical religious structure, are accredited by regional accreditation organizations. In California, Catholic schools receive accreditation from both the Western Association of Schools and Colleges (WASC) and the Western Catholic Education Association (WCEA). Although these schools operate under the general guidance of a central district office, day-to-day management is typically parochial and site-based. The demographic composition and diversity of Catholic schools generally reflect those of the surrounding local communities. Consequently, Catholic schools vary widely in terms of size, student population, access to technology, and the availability of technology-related services for teachers and students. Faculty demographics across these schools also demonstrate diversity in ethnicity, socioeconomic status, and geographic location within the district. Additionally, teachers are required to hold at least a bachelor's degree, and an increasing number are also expected to hold a California teaching credential.

Participants

The target population for this study consisted of approximately 2,500 teachers across 215 elementary schools and 40 high schools in Southern California. Participants were selected using random sampling. Eligible participants were K-12 teachers working in Catholic schools who had access to technological resources and who had opportunities to integrate technology into classroom instruction and learning activities. Participants were also required to be employed at schools with established computer access and expected to have received continuous professional development (PD) training focused on technology integration. The sample consisted of 327 teachers, which, according to Ruel, Wagner III, and Gillespie (2016), is an appropriate sample size for survey validation. This sample size resulted in a margin of error of approximately 5.05% at a 95% confidence level (Raosoft, 2004) and aligns with Israel's (2003) recommended range of 200–500 participants for rigorous instrument evaluation and validation.

The majority of participants identified as female (77.1%), while 22.3% identified as male, and 0.6% selected "Other" as their gender. As it relates to race and ethnicity, the largest proportion of participants self-identified as Hispanic/Latino (40.4%), followed by White (38.5%). Smaller proportions identified as Asian (7.0%), Mixed Race (6.1%), Black/African American, American Indian/Alaska Native, Hawaiian/Other Pacific Islander, or Other (collectively 7.9%). Additionally, most teachers were between 26 and 45 years old (57.2%), with 37.6% over 45 and 5.2% under 26. Participants primarily taught at the elementary (46.2%) and middle school (36.7%) levels. Regarding educational attainment, 59.0% of the participants held a master's degree, 34.9% a bachelor's degree, and a small proportion reported holding either a doctorate (4.0%) or an educational specialist degree (2.1%). Teaching experience ranged from 1 to 42 years, with a mean of 13.4 years (SD = 9.5), a median of 12 years, and a mode of 3 years. Lastly, 25.1% of teachers participated in technology-oriented professional development (PD) sessions once per year, 18.3% reported attending twice per year, 16.8% four times per year, 14.7% monthly, and 14.4% not at all in the past year.

Instrument

An online survey that incorporated the Technology Integration Confidence Scale (TIC-S) version 3 with a set of demographic items was used to collect the data for this study. The demographic variables included age, gender, level of teaching, years of teaching experience, and the number of continuous professional development (PD) hours received related to technology integration. Whereas, the TIC-S version 3 itself consists of 25 Likert-scale items aligned with five key components: Technology Usage, Technology Application, Technology-infused Learning, Technology Literacy and Digital Citizenship, and Technology-supported Assessment.

Each item measures teachers' self-reported confidence in performing specific technology integration tasks, with response options ranging from "Not confident at all" to "Completely confident." The TIC-S version 3 is grounded in Bandura's (1997) self-efficacy theory, which conceptualizes confidence as task-specific and essential for instructional decision-making. The instrument was refined based on previous pre-test and pilot test analyses to ensure alignment with the ISTE Standards for Educators (2017).

Data Collection

Data for this study were collected via an online survey administered to a random sample of 327 K–12 Catholic school teachers in Southern California. Principals of Catholic elementary and high schools were initially contacted by email and invited to encourage teacher participation. The principals then distributed the survey link and participation information, including ethical and confidential concerns, to their faculty.

Teachers who consented to participate completed the survey independently and were informed they could withdraw at any time without penalty by exiting the survey. Weekly email reminders were sent to principals throughout the data collection period to encourage continued recruitment. Survey responses were collected using Qualtrics and analyzed using IBM SPSS Statistical software.

Data Usage and Analysis

The data used in this study were drawn from the same larger dataset reported in Gomez et al. (2022). While the earlier study focused on descriptive outcomes related to teachers' technology integration self-efficacy, the present study extends that work by conducting a comprehensive psychometric validation of the TIC-S version 3 instrument. To address the research questions, two primary statistical approaches were employed to evaluate the instrument's reliability and validity: reliability analysis and instrument validation procedures. Specifically, the analyses included assessments of internal consistency reliability and construct validity.

Cronbach's alpha was used to measure internal consistency and assess the instrument's reliability. For construct validity, Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) was employed. Confirmatory factor analysis (CFA) was not conducted because the underlying factor structure of the revised instrument had not yet been firmly established. Therefore, exploratory factor analytic methods were deemed more appropriate for identifying the instrument's latent dimensions prior to any confirmatory testing. Nonetheless, the analyses employed for this study provided a comprehensive evaluation of the instrument's reliability and validity.

Reliability Analysis

Cronbach's alpha reliability coefficients were used to assess the internal consistency of the overall instrument and its five subscales. A reliability coefficient of .70 or higher was considered acceptable, with values above .90 indicating excellent reliability (Nunnally, 1978).

Construct Validity

Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) with oblique rotation was conducted to identify the underlying factor structure. Both eigenvalue criteria and scree plot analysis were used to determine the appropriate number of factors. Together, these statistical techniques provided measures for a rigorous assessment of the instrument's psychometric properties, so as to confirm its suitability for measuring teachers' technology integration confidence in future research.

Results

Cronbach's alpha reliability coefficients were computed to examine the instrument's reliability for the overall scale and the five subscales. The results presented in Table 3 show the reliability of the overall instrument is .965, which is very high (the threshold is >= 0.8; >= 0.75 is marginally acceptable; Nunnally, 1978). The results also show that the reliability of the 5 subscales is greater than the threshold of .8, which is very good. The reliability coefficients for the subscales range from .866 to .915.

Table 3.TIC-S version 3 Cronbach's Alpha (α) Reliability Coefficient

Subscale	**α**	**N of Items**
1. Technology Usage (TU)	.897	7
2. Technology Application (TA)	.915	5
3. Technology-Infused Learning (TIL)	.866	5
4. Technology Literacy & Digital Citizenship (TLDC)	.903	4
5. Technology-Supported Assessment (TSA)	.886	4
Overall Scale (TIC-S version 3)	**.965**	**25**

Exploratory factor analysis (EFA) was conducted to examine the underlying factor structure of the 25-item Technology Integration Confidence Scale (version 3). The purpose of the EFA was to determine: "(a) how many latent factors underlie responses to the scale, (b) which items are measuring each factor, (c) what substantive label should be given to each factor, and (d) the nature of the correlations between the factors" (Hatcher, 2013, p. 406). Principal component analysis (PCA) with oblique rotation was used to extract factors, beginning with a five-factor solution and subsequently reanalyzed using a four-factor model.

First, to determine the suitability of the data for factor analysis, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were conducted. A KMO value below .50 suggests that the data are not appropriate for factor analysis due to insufficient shared variance among variables; ideally, the KMO should exceed .60. The KMO value for this dataset was .961, indicating marvelous sampling adequacy (Kaiser, 1974). Additionally, Bartlett's test of sphericity was significant, $\chi^2(300) = 6421.056$, $p < .001$, confirming that correlations among variables were sufficiently strong. These results indicate that the data were appropriate for factor analysis.

Communalities indicate the proportion of each variable's variance that can be explained by the extracted factors. Higher communality values suggest that the factors account for more of the item's variance, reflecting better representation in the factor solution. Typically, items with communality values below .20 may be considered for removal, deletion or exclusion, as they contribute little to the underlying factor structure. In this study, all 25 items had extraction communalities ranging from .584 to .830, indicating that each item was well-represented and contributed meaningfully to the factor solution.

The major results of the PCA revealed that five extracted components accounted for 72.24% of the total variance. The rotation sums of squared loadings reflect the factor structure after oblique rotation. As shown in the Pattern Matrix (Table 4), the five components did not align perfectly with the original subscales of the TIC-S version 3. Specifically, items from the first two subscales of Technology Usage and Technology Application loaded together on the first component, suggesting that these subscales may be measuring a single underlying construct—Technology Usage and Application. In contrast, the remaining three components demonstrated clear and theoretically coherent relationships with their respective items, supporting the intended construct alignment with minimal cross-loading.

For the subscale Technology Literacy & Digital Citizenship (TLDC), items 18 through 21 loaded strongly on Component 2, with loadings ranging from .778 to .901. These high values, coupled with minimal cross-loading, suggest a well-defined and distinct TLDC construct. Similarly, items 13 through 17 for the Technology-Infused Learning (TIL) subscale loaded clearly on Component 3, with loadings between -.585 and -.782. The negative direction of the loadings is acceptable given the use of oblique rotation. Item 15 showed the strongest contribution (-.782), and all five items aligned distinctly with the TIL construct, reinforcing its construct validity. For the Technology-Supported Assessment (TSA) subscale, items 22 through 25 loaded significantly on Component 4, with values ranging from -.659 to -.858. Item 24 exhibited the highest loading (-.858). As with the other subscales, the strong loadings and minimal cross-loading indicate a clearly defined and theoretically coherent TSA construct.

To examine the viability of a four-factor (as opposed to the original five-factor structure) model for the TIC-S version 3, an additional EFA using PCA with oblique rotation was conducted, specifying four factors. The PCA results indicated that the four extracted components accounted for 69.08% of the total variance. The rotation sums of squared loadings represent the factor structure following oblique rotation. As shown in Table 5, the pattern matrix revealed that the extracted components closely aligned with the intended subscale structure of the TIC-S version 3. This analysis establishes and supports a clear and coherent four-factor solution: Technology Usage & Application (TUA), Technology-Infused Learning (TIL), Technology Literacy and Digital Citizenship (TLDC), and Technology-Supported Assessment (TSA).

Table 4. Pattern Matrix of Five Components Extracted

Pattern Matrix[a]					
Items	**Components**				
	1	2	3	4	5
1	.092	.017	-.062	-.092	.781
2	.297	.056	-.323	.100	.500
3	.518	.041	.134	-.210	.395
4	.615	.103	-.114	-.018	.087
5	.735	.197	.043	-.001	.072
6	.740	.061	-.110	.100	.030
7	.735	-.002	.040	-.181	.041
8	.640	.025	-.058	-.153	.120
9	.350	.010	-.393	-.180	.122
10	.568	.062	-.200	-.245	-.179
11	.366	-.025	-.214	-.438	-.005
12	.284	.047	-.263	-.317	.120
13	.012	.101	-.585	-.009	.244
14	-.020	.071	-.632	-.233	.159
15	-.008	.050	-.782	-.064	.037
16	.034	.264	-.594	-.099	.024
17	.292	-.023	-.592	-.048	-.200
18	.128	.895	.045	.082	-.081
19	.024	.778	-.159	-.056	-.069
20	-.062	.901	.027	-.027	.105
21	-.030	.822	-.003	-.126	.015
22	.068	.153	.021	-.678	.128
23	-.054	.046	-.226	-.659	.098
24	.086	.001	.052	-.858	-.070
25	-.021	.153	-.101	-.748	.031

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 12 iterations.

For the subscale Technology Usage & Application (TUA), Items 1 through 12 predominantly loaded on Component 1, with factor loadings ranging from .362 (Item 12) to .833 (Item 3). Notably, Items 3, 5, 6, 7, and 8 demonstrated strong loadings above .70, reinforcing the construct validity of the TUA subscale. The presence of high loadings and minimal cross-loading suggests a clearly defined and distinct TUA construct. Similarly, for the subscale Technology Literacy & Digital Citizenship (TLDC), Items 18 through 21 loaded strongly and exclusively on Component 2, with loadings ranging from .784 (Item 19) to .920 (Item 20), further supporting the integrity and distinctiveness of the TLDC construct.

Whereas, for the subscale Technology-Infused Learning (TIL), Items 13 through 17 loaded strongly on Component 3, with loadings ranging from -.625 (Item 17) to -.853 (Item 15). The negative direction of the loadings is acceptable due to the use of oblique rotation. Item 15 exhibited the strongest contribution (-.853), and all five items aligned clearly with the intended TIL construct. The presence of strong loadings and minimal cross-loading supports the construct validity and distinctiveness of the TIL subscale.

Table 5. Pattern Matrix of 4 Components Extracted

Pattern Matrix[a]				
Items	**Components**			
	1	2	3	4
1	.708	.034	-.097	.168
2	.642	.033	-.334	.217
3	.833	.045	.133	-.108
4	.644	.071	-.096	-.054
5	.761	.164	.083	-.060
6	.710	.012	-.069	.010
7	.748	-.023	.056	-.223
8	.709	.006	-.053	-.161
9	.403	-.002	-.433	-.143
10	.395	.044	-.213	-.323
11	.353	-.013	-.270	-.405
12	.362	.054	-.314	-.252
13	.149	.090	-.638	.082
14	.061	.077	-.717	-.128
15	-.049	.034	-.853	-.026
16	.000	.256	-.651	-.064
17	.065	-.057	-.625	-.129
18	.053	.891	.074	.040
19	-.046	.784	-.170	-.057
20	.026	.920	.026	.032
21	-.011	.844	-.015	-.084
22	.214	.213	-.065	-.527
23	.049	.102	-.335	-.504
24	.090	.071	-.050	-.746
25	.045	.218	-.208	-.605

Extraction Method: Principal Component Analysis.

Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 11 iterations.

Lastly, for the subscale Technology-Supported Assessment (TSA), Items 22 through 25 loaded strongly on Component 4, with loadings ranging from -.504 (Item 23) to -.746 (Item 24). Item 24 exhibited the strongest contribution (-.746), and all four items aligned clearly with the intended TSA construct. The strong loadings and minimal cross-loading support the distinctiveness and construct validity of the TSA subscale.

Since the subscales Technology Usage and Technology Application were combined to form the Technology Usage & Application (TUA) subscale to align with the four-factor structure model of the TIC-S version 3, the Cronbach's alpha reliability coefficient for the combined subscale was computed. As shown in Table 6, the reliability of the combined subscale was .943, indicating excellent internal consistency. Notably, this coefficient is higher than those of the individual subscales prior to combination (TU $\alpha = .897$; TA $\alpha = .915$), further supporting the decision to merge them.

Table 6. TIC-S version 3 Cronbach's Alpha (α) Reliability Coefficient for Four Subscales

Subscale	**α**	**N of Items**
1. Technology Usage & Application (TUA)	.943	12
2. Technology-Infused Learning (TIL)	.866	5
3. Technology Literacy & Digital Citizenship (TLDC)	.903	4
4. Technology-Supported Assessment (TSA)	.886	4
Overall Scale (TIC-S version 3)	**.965**	**25**

Overall, the pattern matrix confirms the four-factor structure of the TIC-S version 3 instrument, with each item loading strongly on its intended subscale. The magnitude of the loadings and minimal cross-loadings indicate robust construct validity. These findings reinforce the theoretical framework underlying TIC-S version 3 and provide empirical justification for its continued use in assessing teacher confidence across key domains of technology integration.

Discussion

Educational technology is an indispensable element of teaching at all instructional levels (Seifert, 2019). Whether teaching in traditional classrooms or online environments, educators must possess the knowledge and skills necessary to design and successfully implement technology-enhanced learning experiences (Seifert, 2019; Thakur, 2015). In response to this evolving reality, the use of digital technology in today's classrooms continues to grow in importance, supported by increasing access to computers and technology training (HMH, 2018; Kay, 2006). Consequently, there is a pressing need for reliable instruments that can assess teachers' confidence in effectively integrating technology into their practice. This need underpins the development and validation of the Technology Integration Confidence Scale (TIC-S) version 3, which is designed to measure key tasks associated with effective technology integration in contemporary educational settings.

Substantial evidence supporting the validity of TIC-S version 3 has been established. This validation study confirms that the third iteration of the TIC-S instrument is a reliable tool for measuring teachers' self-efficacy (confidence) in integrating technology into the classroom. The Cronbach's alpha (α) reliability coefficient for the subscales of the TIC-S version 3 in this validation study ranged from .866 to .915, compared to .800 to .900 for Browne's (2007) TIC-S version 2. As implied, the TIC-S version 3 advances the work of Browne's (2007) TIC-S version 2, which was a rigorously developed self-efficacy scale aligned with the second-generation (2007) ISTE National Educational Technology Standards for Teachers (NETS-T). While Browne's (2007) TIC-S version 2 focused more narrowly on measuring teachers' confidence in executing specific technological skills, the TIC-S version 3 emphasizes teachers' self-efficacy in effectively integrating technology as part of instructional practice (i.e., students and teachers using technology during instruction).

Accordingly, the TIC-S version 3 was originally developed with five subscales (see Table 2), aligned with the seven benchmarks of the current (2017) ISTE Standards for Educators: Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst (see Table 1). However, findings from this validation study indicate that the instrument is better represented by a four-factor structure rather than the original five. Subsequently, the first two subscales were merged to form a unified construct. A clear and coherent four-factor solution thus emerged, aligning with the revised subscale structure of the TIC-S version 3: Technology Usage & Application (TUA), Technology-Infused Learning (TIL), Technology Literacy & Digital Citizenship (TLDC), and Technology-Supported Assessment (TSA).

Implications for Professional Practice

Over time, with purposeful support and sustained classroom practice, teachers gain both experience and self-efficacy. This is critical, as teachers with high self-efficacy are better equipped to adapt to evolving technologies, such as AI-powered tools and platforms, and are more prepared to effectively integrate them into their classrooms (Ertmer & Ottenbreit-Leftwich, 2010; Gilakjani, 2013; Mishra & Koehler, 2006; Tweed, 2013). A teacher's experience with technology has a significant impact on the extent and quality of technology integration in the classroom (Liu et al., 2017). Moreover, the frequency of technology use, combined with the teacher's confidence and comfort in applying technological tools, further mediates successful classroom integration (Liu et al., 2017).

The ultimate goal is to foster high levels of self-efficacy among teachers, positioning them to confidently adapt to emerging technologies and become more effective users and integrators of technology in K-12 education. In this regard, the TIC-S version 3 serves as a valuable research instrument and practical indicator of teachers' comfort and confidence levels with technology integration. It can help guide professional development efforts and support teachers in building the techno-pedagogical skills necessary to meet the evolving demands of technology-enhanced learning environments.

Instrumentation and Usage

The Technology Integration Confidence Scale version 3 is a standardized, 25-item, forced-choice, multidimensional instrument designed to assess four key aspects of technology integration within the context of teachers' self-efficacy and techno-pedagogical competence—that is, the intersection of technological proficiency and the confidence required to effectively integrate technology into instruction. These four core components, confirmed by the present validation study, are:

1. *Technology Usage & Application (TUA)*
   - This subscale evaluates teachers' confidence in using and modeling technological devices and digital tools to support student learning, as well as their ability to integrate these tools into lessons and provide students with opportunities to apply them during instruction.
2. *Technology-Infused Learning (TIL)*
   - This subscale assesses teachers' confidence in facilitating student-centered learning through effective use of technology in the classroom.
3. *Technology Literacy & Digital Citizenship (TLDC)*
   - This subscale explores teachers' confidence in using technology to communicate information, enhance learning, and teach students the necessary skills and concepts for responsible technology use.
4. *Technology-Supported Assessment (TSA)*
   - This subscale examines teachers' confidence in creating technology-rich environments that support meaningful assessment and timely feedback.

These four components collectively reflect teachers' readiness and preparedness to integrate technology into instructional practice.

The Technology Usage & Application subscale consists of 12 items, while the Technology-Infused Learning subscale includes 5 items. The Technology Literacy & Digital Citizenship and Technology-Supported Assessment subscales each comprise 4 items. All items follow a consistent 6-point Likert-type response format, allowing participants to indicate their level of agreement or confidence regarding specific technology integration tasks.

Sample items include:

- "How confident are you in facilitating and supporting student learning opportunities with technology?" (TUA), and
- "How confident are you in using digital tools to provide immediate feedback to students?" (TSA).

Responses are scored to yield subscale scores for each of the four dimensions. Mean scores can also be averaged to provide an overall measure of teachers' self-efficacy in technology integration.

Assumptions

Since this study utilized an online survey, it was assumed that participants responded to all questions honestly and to the best of their abilities, ensuring that the data collected was as accurate and reliable as possible. It was also assumed that a sample size of 327 participants was sufficient to provide adequate statistical power for the analyses conducted. This sample size is consistent with Israel's (2003) recommendation, which suggests that a sample of approximately 200 to 500 participants is appropriate for performing rigorous evaluations and analyses, including those required to retest an instrument and establish its reliability and validity.

Generalizability

The findings of this study should be interpreted within the context of its defined sample and setting. The validation of the Technology Integration Confidence Scale (TIC-S) version 3 was conducted with a sample of 327 K–12 teachers drawn from urban Catholic schools in Southern California. While the sample size meets established thresholds for rigorous instrument validation and reflects a diverse range of teacher demographics (e.g., grade levels, years of experience, and ethnic backgrounds), the study's geographic and institutional scope may influence the extent to which the findings can be generalized to broader educational populations. Catholic school systems often share organizational structures, mission-driven educational frameworks, and professional expectations that may differ from those of public, charter, or international school contexts. As such, the psychometric properties and factor structure identified in this study may not fully replicate across educational settings with differing resources, governance models, or levels of technology access.

At the same time, several aspects of the study support cautious generalizability. The TIC-S version 3 is grounded in widely recognized theoretical and professional frameworks, including Bandura's (1997) self-efficacy theory and the ISTE Standards for Educators (2017), which are broadly applicable across K–12 educational contexts. Additionally, the diversity of participating schools and teacher backgrounds within the Southern California Catholic system provides a degree of variability that strengthens the instrument's potential applicability beyond the immediate sample. Nevertheless, further validation studies involving more heterogeneous populations, i.e., across geographic regions, school types, and instructional environments, are recommended to confirm the stability of the four-factor structure and to enhance the external validity of the instrument. Such efforts would further establish TIC-S version 3 as a robust tool for assessing teacher self-efficacy in technology integration across diverse educational settings.

Recommendations for Future Research

Building on the findings of this study, several avenues for future research are recommended. First, additional studies should be conducted with larger and more diverse populations across different educational settings, including public, private, and charter schools, to enhance the generalizability of the TIC-S version 3 instrument. Expanding the sample to include teachers from varied geographic regions and grade levels would provide broader insights into teachers' technology integration confidence.

Second, future research should consider using longitudinal designs to track changes in teachers' technology self-efficacy over time, particularly in response to targeted professional development, evolving educational technologies, or shifts in instructional practices. Longitudinal data would provide valuable evidence on how technology integration confidence develops and the factors that sustain or diminish it.

Third, qualitative or mixed-methods studies could further enrich understanding by exploring teachers' personal experiences, challenges, and contextual factors that influence their confidence in using technology. Such approaches could provide deeper insights that quantitative data alone may not fully capture.

Fourth, future validation of the TIC-S version 3 instrument across varied instructional environments and with different technological tools is recommended to continue refining its reliability and applicability. Investigating its predictive power regarding actual technology integration behaviors in the classroom would also strengthen its practical utility.

Fifth, to further refine the reliability of the instrument, particularly the Technology Usage & Application (TUA) subscale, it is recommended that future research collect data from an adequately sized sample and retest the four-factor structure of the TIC-S version 3 using Confirmatory Factor Analysis (CFA) to evaluate the reliability and validity of the factor structure identified through this study's EFA.

Finally, artificial intelligence (AI) is advancing at a breakneck pace in both its applications and potential uses in schools. It is likely that the utilization of AI in education (AIEd) will be included as one of the core competencies in the next iteration of the ISTE Standards, as the recent ISTE+ASCD merger strengthens professional development and empowers educators worldwide to safely, ethically and responsibly use AI in teaching and learning (ISTE 2024). Therefore, a recommendation for future research related to the advancement and development of TIC-S version 4 is the inclusion of AI-related subscale. Possible AIEd applications for such an AI-related subscale may include adaptive learning systems that adjust content to individual needs, intelligent tutoring systems that provide personalized instruction, generative AI for creating quizzes, learning materials, and other creative educational tools for both students and instructors, AI-powered chatbots offering student support, and automated grading and feedback systems to assess student progress, along with other technologies designed to support teachers and administrators.

Limitations

Although this study was carefully designed and employed rigorous statistical procedures to evaluate the reliability and validity of the TIC-S version 3 instrument, several limitations must be acknowledged.

First, the study relied on self-reported data collected through an online survey, which introduces the potential for response bias. Participants may have overestimated or underestimated their confidence in integrating technology due to social desirability, perceived expectations, or differing interpretations of survey items. While participants were encouraged to respond honestly, the accuracy of self-reported perceptions of self-efficacy cannot be independently verified. As such, the findings reflect perceived confidence rather than direct observation of actual classroom technology integration practices.

Second, the study's sample, although adequate in size ($n = 327$) and consistent with recommended thresholds for instrument validation, was drawn exclusively from K–12 teachers within Southern California Catholic schools. This geographic and institutional focus may limit the generalizability of the findings to broader educational contexts, including public, charter, or international school systems. Catholic schools, while diverse, may share organizational, cultural, and instructional characteristics, such as governance structures, access to resources, and professional development expectations, that differ from other educational settings. Therefore, the extent to which the results can be generalized to other populations should be interpreted with caution.

Third, although random sampling procedures were used, participation was voluntary and mediated through school leadership (i.e., principals distributing the survey), which may have introduced elements of selection bias. Teachers who chose to participate may have had greater interest in or confidence with technology integration, potentially skewing the results toward higher reported levels of self-efficacy. Additionally, eligibility criteria required participants to have access to technology and opportunities for integration, which may exclude teachers in lower-resource environments and further limit representativeness.

Fourth, the cross-sectional design of the study captures teachers' self-efficacy at a single point in time. As such, it does not account for changes in technology integration confidence that may occur over time, particularly in response to ongoing professional development, evolving instructional practices, or rapid advancements in educational technology. Longitudinal research would be necessary to better understand how teachers' self-efficacy develops, fluctuates, or is sustained over time.

Fifth, while the study employed exploratory factor analysis (EFA) to establish the underlying factor structure of the instrument, confirmatory factor analysis (CFA) was not conducted. As noted in the methodology, EFA was appropriate given the revised structure of the instrument; however, the absence of CFA limits the extent to which the proposed four-factor model can be definitively confirmed. Future studies should employ CFA with independent samples to further validate the factor structure and strengthen the instrument's construct validity.

Finally, although the TIC-S version 3 demonstrated strong psychometric properties, including high internal consistency and a well-defined four-factor structure, further validation across more diverse populations, grade levels, and instructional environments is warranted. Expanding the use of the instrument to include varied geographic regions, school types, and levels of technological access would enhance its generalizability and applicability. Additionally, future research examining the relationship between self-efficacy scores and observed instructional practices would strengthen the instrument's practical utility and predictive validity.

Conclusion

This quantitative study sought to validate the Technology Integration Confidence Scale (TIC-S) version 3, which had previously undergone pre-testing and pilot testing. Aligned with the seven benchmarks of the current (2017) iteration of the International Society for Technology in Education (ISTE) Standards for Educators, the TIC-S version 3 builds upon Browne's (2007) earlier development of TIC-S version 2. In light of the revised subscale structure identified through exploratory factor analysis (EFA), TIC-S version 3 reflects four essential components of technology integration: Technology Usage and Application, Technology-Infused Learning, Technology Literacy and Digital Citizenship, and Technology-Supported Assessment. These dimensions represent key aspects of techno-pedagogical competence necessary for effective teaching in contemporary, technology-rich learning environments.

Using a sample of 327 teachers and rigorous statistical procedures, including EFA via principal component analysis with oblique rotation, the analysis confirmed the instrument’s reliability and validity. The overall Cronbach’s alpha coefficient (.965) and strong subscale reliabilities (.866–.943) indicate excellent internal consistency, while the four-factor solution accounted for 69.08% of the total variance, exceeding accepted thresholds for construct validity. These findings support TIC-S version 3 as a psychometrically robust instrument for assessing teachers’ self-efficacy in technology integration.

Beyond its statistical validation, this study offers important implications for professional practice. The TIC-S version 3 provides educators, instructional leaders, and professional development providers with a practical diagnostic tool for identifying teachers’ strengths and areas of need in technology integration. By leveraging the instrument’s four subscales, schools can design more targeted and differentiated professional development initiatives that address specific dimensions of techno-pedagogical competence, such as technology-supported assessment or digital citizenship. In an era marked by rapid technological advancement, including the increasing integration of artificial intelligence (AI) in education, fostering teacher self-efficacy is critical for ensuring meaningful and sustained instructional innovation. As such, TIC-S version 3 can serve as a guiding framework for supporting teachers in adapting to emerging technologies and enhancing student-centered, technology-infused learning environments.

This study also contributes to the research literature by providing a validated framework for examining teacher self-efficacy in technology integration. The findings establish a foundation for future research exploring the relationship between teachers’ perceived confidence and their actual classroom practices, including the extent and quality of technology integration. Additionally, the results support the need for longitudinal studies to investigate how teacher self-efficacy evolves over time, particularly in response to targeted professional development, changing instructional demands, and advancements in educational technology. Further research is also warranted to validate the TIC-S version 3 across diverse educational contexts and to examine its predictive validity in relation to student outcomes and instructional effectiveness.

Finally, as educational technologies continue to evolve, future iterations of the TIC-S instrument may benefit from the inclusion of emerging competencies, particularly those related to artificial intelligence in education (AIEd). Expanding the instrument to capture teachers’ confidence in using AI-driven tools, such as adaptive learning systems, generative AI applications, and automated assessment platforms, would enhance its relevance and applicability in contemporary educational settings. Collectively, the findings of this study position TIC-S version 3 not only as a reliable measurement tool but also as a meaningful framework for advancing both research and practice in technology integration within K–12 education.

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Data Availability: The data used in this study were drawn from the same larger dataset reported in Gomez et al. (2022). While the earlier study focused on descriptive outcomes related to teachers' technology integration self-efficacy, the present study extends that work by conducting a comprehensive psychometric validation of the TIC-S version 3 instrument.

Ethics Approval: The study was performed in accordance with the study protocol and ethical guidelines and regulations.

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