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Research Article

Examination of the relationship between information and communication technology competencies and communication skills

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ABSTRACT

This study aimed to explore the impact of different dimensions of communication skills, namely competence (COMP), self-esteem (SELF), social communication challenge (SCC), and listening-speaking (LI-S) on the utilization of information and communication technology (ICT) for student support (SS) and instructional design (ID). This study implemented inferential statistical methods to explore the impact of different dimensions of communication skills on the utilization of ICT among pre-service teachers. A sample of 324 pre-service teachers from Kazan Federal University was examined, utilizing validated scales adapted to the Russian context, with data analyzed using structural equation modeling to identify complex relationships between variables and to ascertain potential differences according to gender and department. The results demonstrated a significant positive relationship between participants' perceived COMP in communication skills and their information and communication technology competencies (ICTCs), both in SS and ID. This suggests the need for targeted training to enhance educators' communication competencies for optimal ICT utilization. Conversely, SELF and LI-S communication skills did not

significantly influence ICTCs, indicating that these elements do not necessarily result in more effective ICT use in educational contexts. However, handling SCCs was positively associated with ICTCs in ID but not for SS, indicating a nuanced relationship between different communication skills and areas of ICT utilization. The study findings provide implications for professional development programs and underline the importance of certain dimensions of communication skills in leveraging ICT in education. Further research is recommended to verify these findings across different populations and educational settings.

Keywords: information and communication technology competency, communication skills, pre-service teacher, structural equation modeling

INTRODUCTION

Information and communication technology (ICT) skills are considered essential prerequisites, as numerous educational institutions are emphasizing the incorporation of ICTs in teaching, recognizing their significance for contemporary students (Abramova & Shishmolina, 2022; Jita & Sintema, 2022; Rubach & Lazarides, 2021). This increasing reliance on ICT in education is reflective of broader societal trends, where digital competency has become a key skill across many sectors (Oberländer et al., 2020). Moving beyond the general trend in education, the growing importance of ICT skills is especially evident in the context of teacher preparation (Starkey, 2020). With the rapid integration of ICT into education, it becomes more and more critical for pre-service teachers to be proficient in the use of ICT. This shift towards digital education has led to a necessary change in the training and development of future educators (Vilppola et al., 2022). However, as we navigate this new landscape, it is important to acknowledge that training pre-service teachers to integrate ICT tools is a complex process (Uerz et al., 2018). Thus, understanding this complexity is key in designing and implementing effective teacher education programs to meet the demands of 21st century classrooms.

On the other hand, the acquisition of communication skills is of utmost importance for pre-service teachers due to a multitude of reasons. The act of teaching fundamentally entails the acquisition of knowledge and skills to individuals (Khotinets et al., 2022; Szymkowiak et al., 2021), thereby requiring the use of concise and efficient communication (Muste, 2016). A skilled communicator possesses the ability to effectively express intricate ideas in a comprehensible and captivating manner, thereby fostering students' inquisitiveness and facilitating their acquisition of knowledge (Priadi, 2020). Educators frequently engage with diverse stakeholders, including parents, administrators, and colleagues, to foster productive relationships, promote comprehension, and facilitate collaboration (Chatzinikola, 2022). Furthermore, the role of educators extends beyond the mere transmission of information, encompassing active listening and empathy (Kourmousi et al., 2018). It is imperative for teachers to comprehend the challenges, emotions, and feedback of their students to effectively address their needs (Davis et al., 2022). Pre-service educators undergo a period of learning and personal growth, during which the acquisition of effective communication skills facilitates their ability to assimilate instruction, feedback, and guidance provided by their mentors (Fukkink et al., 2019; Ntshangase & Nkosi, 2022). Consequently, developing these skills at an early stage can greatly improve their effectiveness as educators and contribute to their professional development.

The proficiency in communication skills is essential for pre-service teachers to effectively utilize ICT. In the context of the progressively digitized educational environment, educators are required to possess proficiency in utilizing diverse ICT tools to enhance the quality of learning encounters (Latipov et al., 2019; Vasyliuk et al., 2021). Effective communication skills, encompassing both written and verbal proficiency (Defede et al., 2021; Stephenson et al., 2015), enable educators to generate, comprehend, and disseminate educational materials through diverse digital platforms thereby ensuring the content is both significant and easily comprehensible for students (McGarr & McDonagh, 2021; Vajen et al., 2023). The task at hand encompasses not only the technical dimension, but also the art of formulating the message in a manner that is accessible, captivating, and inclusive to the user (Sdeeq et al., 2021). Furthermore, with the increasing prevalence of collaborative learning environments, it is imperative for teachers to proficiently employ ICT to foster group interactions and promote effective teamwork (Kim et al., 2019). Significantly, the acquisition of digital communication skills allows pre-service teachers to effectively exchange ideas, solicit feedback, and engage in collaborative endeavors with peers or mentors situated in diverse geographical locations, including international contexts

(Kazemian et al., 2021). Therefore, the proficiency of pre-service teachers in utilizing digital technologies for educational purposes is greatly impacted by their communication skills.

The primary aim of this study is to scrutinize the potential relationship between the communication skills and information and communication technology competence (ICTC) of pre-service teachers. Given the rapidly evolving digital landscape of modern education, ICTC is of paramount importance for teachers. However, the role of communication skills in shaping this ICTC remains an under-researched area. This study seeks to fill this gap by investigating if and how the communication abilities of teacher candidates contribute to their ability to effectively use ICT for educational purposes. The findings from this study could provide valuable insights for teacher education programs, potentially highlighting the necessity to concurrently develop communication skills and ICTC among pre-service teachers to prepare them for the demands of the 21st century classrooms.

Communication Skills

Communication skills encompass a diverse range of competencies that facilitate the effective and efficient exchange of information, ideas, and emotions with individuals. The skills encompassed in this category consist of verbal communication, which entails the ability to express oneself clearly and effectively through speech, as well as non-verbal communication, which encompasses the use of body language and facial expressions to convey messages (Cuic Tankovic et al., 2023; Light & McNaughton, 2014). Listening skills, which are considered to be of utmost importance, encompass the ability to comprehend and analyze both spoken and non-verbal forms of communication from individuals (Rateb Darawsheh, 2022). Proficiency in written communication is crucial, as it necessitates the capacity to articulate thoughts clearly through written technological means (Tarisman & Hanafi, 2020). In addition, the acquisition of communication skills encompasses the capacity to modify one's communication approach in accordance with varying contexts and audiences, as well as to proficiently engage in the exchange of feedback. The acquisition of effective communication skills is imperative across various domains, encompassing personal relationships, education, and employment (Reed & Trumbo, 2020).

Communication skills are often assessed using a combination of qualitative and quantitative techniques since they are a crucial ability in both the personal and professional domains (Comert et al., 2016; Rubin & Martin, 1994). Structured methods like self-report surveys and standardized exams, which offer numerical data on people's communication skills, are frequently used in quantitative evaluations (Mamzer, 2018). One tool that is frequently used to test different aspects of communication competence is the interpersonal communication competence scale (ICCS) (Rubin & Martin, 1994), which examines traits including self-disclosure, empathy, and flexibility (Puggina & Da Silva, 2014). On the other hand, qualitative evaluations like in-depth interviews and observational approaches provide extensive, contextual insights about people's communication practices and their efficacy in actual settings (Alshumaimeri & Alhumud, 2021; Rasipuram et al., 2016). These techniques frequently employ professional observers or raters who assess people's communication abilities in accordance with predetermined standards. Recent study has also looked into using technology, including automated voice and language processing tools, to test communication abilities in an objective manner (Calero Valdez et al., 2019). The measuring of communication abilities is intricate and multidimensional, and no one approach can adequately account for all facets of this crucial talent.

One of the measurement tools of communication skills is the communication skills scale developed by Akkuzu and Akkaya (2014). The scale is composed of 25 items, divided into five distinct sub-dimensions, each containing five items. These sub-dimensions include empathy, expressing emotions, social skills, persuasion, and listening. Each item on the scale is rated using a 5-point Likert scale, with options ranging from "never" to "always". The total score can range from a minimum of 25 to a maximum of 125, with higher scores indicating superior communication skills. This self-administered scale is suitable for both research and clinical applications.

In addition to the general communication skills scale, measurement tools specific to different sectors are also being developed. For example, the health professionals communication skills scale is developed for health professions. The scale preserves the original structure proposed by Juliá-Sanchis et al. (2020), with four dimensions: informative communication, empathy, respect, and assertiveness. However, the data fitting required a structure with correlated measures between items 16 and 18, which was suggested by the

modification indices obtained after the confirmatory factor analysis (CFA). This covariance has been observed in other samples as well, suggesting a need for rewording of items 16 and 18 in future studies. The scale also confirmed the one-dimensionality of the measurement instrument, with the subscales proposed as second-order factors underlying a general factor that evaluates communication skills. This new model offers a single total score for communication skills. The internal consistency for the subscales informative communication and social skills did not reach values of 0.7, being acceptable when the value is ≥0.70 (Juliá-Sanchis et al., 2020).

Effective teaching and learning necessitate the possession of essential communication skills. Current research has been dedicated to examining different facets of communication proficiency among pre-service educators, encompassing their growth, implementation, and the consequences of targeted interventions on these proficiencies. The enhancement of communication abilities in pre-service educators is a complex and multifaceted undertaking. The significance of cultivating research competence, which encompasses critical thinking, ethical reasoning, and proficient communication of research findings, is underscored in a study (Gussen et al., 2023). This underscores the necessity for pre-service educators to possess the ability to articulate intricate concepts with clarity and efficacy. Recent research has also placed emphasis on the utilization of communication skills in the context of teaching practice. According to a study conducted by researchers (Kinskey, 2017), pre-service teachers were observed to employ various language skills, including speaking, listening, and writing, in order to comprehend the significance of incorporating nature of science instruction in their educational practices. This implies that effective communication abilities are crucial not only for delivering instruction directly, but also for comprehending and interpreting pedagogical concepts. The ability to effectively communicate with specific groups, such as parents of English learners and students with extensive support needs, is a crucial component of pre-service teachers' communication skills. The significance of these particular communication skills is underscored by the findings presented in the studies (Tinajero et al., 2023; Walker et al., 2022). The aforementioned studies indicate that it is imperative for pre-service teachers to cultivate the capacity to modify their communication strategies in order to effectively cater to the requirements of varied student and parental populations. Numerous scholarly inquiries have been conducted to examine the effects of targeted interventions on the communication abilities of individuals in the pre-service teaching profession. Malik et al. (2018) discovered that the implementation of a higher order thinking laboratory focused on electric circuits resulted in notable enhancements in the communication skills of pre-service physics teachers. In a similar vein, Celik and Alpan (2023) discovered that the empathic tendency levels of pre-service teachers were significantly influenced by an effective communication course that incorporated heightened student engagement. The findings of these studies indicate that the implementation of focused interventions can significantly improve the communication abilities of pre-service teachers. In summary, recent scholarly investigations pertaining to communication skills among pre-service educators have underscored the significance of these proficiencies in facilitating successful pedagogy and knowledge acquisition. Future research could explore optimal strategies for cultivating and augmenting these proficiencies among pre-service educators.

Information & Communication Technology Competencies

ICTCs among pre-service teachers encompass a range of proficiencies, including skills, knowledge, and attitudes, that are essential for the successful integration of technology into their instructional methodologies. These competencies encompass a wide array of domains.

Firstly, technical skills encompass the proficiency in utilizing a diverse range of software and hardware, digital tools, and online platforms that hold relevance within educational environments (Huda et al., 2018; López-Meneses et al., 2020; Tran et al., 2020). This encompasses a range of skills, starting from fundamental word processing and spreadsheet abilities to more sophisticated proficiencies such as developing multimedia presentations, utilizing interactive whiteboards, or overseeing virtual learning environments (Huda et al., 2018). Additionally, ICTCs encompass pedagogical skills that are associated with technology. This entails acquiring proficiency in utilizing technology to facilitate and enhance the process of teaching and learning (Bladergroen & Chigona, 2019; Jita & Sintema, 2022). This includes tasks such as creating learning activities that incorporate technology, adapting instruction to meet individual student needs using technology, and evaluating student learning within technologically advanced educational settings (García-Martín & García-Sánchez, 2017; Tomczyk et al., 2022). Furthermore, an essential component of these competencies

encompasses a comprehensive comprehension of the significance of technology within the realm of education. It is imperative for pre-service educators to possess the capacity to assess the efficacy and suitability of diverse technologies in relation to various educational objectives (Kukul, 2022). Additionally, they should demonstrate comprehension of the ethical and safety implications associated with the utilization of technology within the classroom setting, while also exhibiting awareness of matters pertaining to digital equity and accessibility (Tomczyk et al., 2022). ICTCs encompass a favorable disposition towards technology. It is imperative for pre-service educators to exhibit a willingness to embrace novel technologies, demonstrate a commitment to regularly enhancing their proficiencies in tandem with technological advancements, and acknowledge the inherent capacity of technology to augment pedagogy and facilitate the learning process (Aslan & Zhu, 2017; Tondeur et al., 2018). ICTCs among pre-service teachers encompass more than mere technical skills. They entail a comprehensive comprehension of how technology can be proficiently and ethically incorporated into instructional methodologies to enhance student learning.

ICT in the field of education has garnered considerable attention and has become a prominent area of scholarly investigation in recent times. Numerous studies have investigated ICTCs of pre-service teachers, their perceptions of these competencies, and the factors that influence their incorporation of ICT into their instructional methodologies. The evaluation of pre-service teachers' competencies and digital skills has been conducted within the framework of the challenges presented by the 21st century (Niyazova et al., 2023). The research revealed a significant correlation between ICT proficiency and digital skills, indicating a strong interdependence between these domains and their essentiality in facilitating effective pedagogy in the era of digital technology. In a similar vein, an additional research endeavor conducted a comprehensive analysis and exploration of the digital proficiencies of pre-service educators, drawing upon the framework of DigCompEdu. This investigation underscored the significance of cultivating these proficiencies as an integral component of the educational journey (Haslaman et al., 2023). Previous studies have also directed their attention towards the perceptions of pre-service teachers regarding their competencies in ICT and technological pedagogical content knowledge (TPACK). This study posits that gaining insight into the self-perceived competencies of pre-service teachers can offer valuable perspectives for teacher education programs seeking to improve these competencies (Demirtas & Mumcu, 2021). Previous research has indicated that the self-efficacy beliefs held by pre-service teachers in relation to the integration of ICT have a significant influence on their level of competence in utilizing ICT. This study posits that the beliefs held by pre-service teachers regarding their own abilities can have a substantial impact on their acquisition of ICTCs. This underscores the significance of cultivating favorable self-efficacy beliefs within teacher education programs (Zhang et al., 2023). A research study was conducted in Henan Province, China, with the aim of examining the various factors that influence the integration ICT among in-service teachers. The findings of this study offer valuable insights that may also be applicable to pre-service teachers (Peng et al., 2023). The research revealed that there are various crucial elements that influence the integration of ICT by teachers, as well as their interactions. This implies that a comprehensive strategy is necessary to provide adequate support to teachers in effectively incorporating ICT into their instructional methods. Previous studies have investigated the proficiency and instructional utilization of ICT among pre-service teachers, particularly their preparedness to create collaborative learning experiences with students. This study posits that the acquisition of ICT proficiency encompasses more than just technical aptitude, but also encompasses the capacity to effectively apply these skills to augment the process of instruction and learning (Stockless et al., 2022). In summary, recent studies on ICTCs among pre-service teachers have emphasized the significance of these competencies in facilitating effective teaching and learning in the contemporary era. Future research endeavors could be directed towards exploring optimal strategies for the cultivation and augmentation of these proficiencies in pre-service educators.

While previous studies have examined pre-service teachers' communication and ICT skills separately, there remains a gap in understanding the relationship between these two essential skills. Despite the rapid integration of technology into education, no studies have directly examined whether and how pre-service teachers' communication skills may influence their ICT literacy. This is a significant gap, as both communication skills and ICT literacy are critical for 21st century teachers. Effective communication enables clear explanation of concepts, promotes classroom dialogue and facilitates collaboration, which are essential skills for technology-enhanced instruction. Thus, pre-service teachers' communication skills could plausibly influence their ability to effectively use technology in pedagogy. However, the potential link between

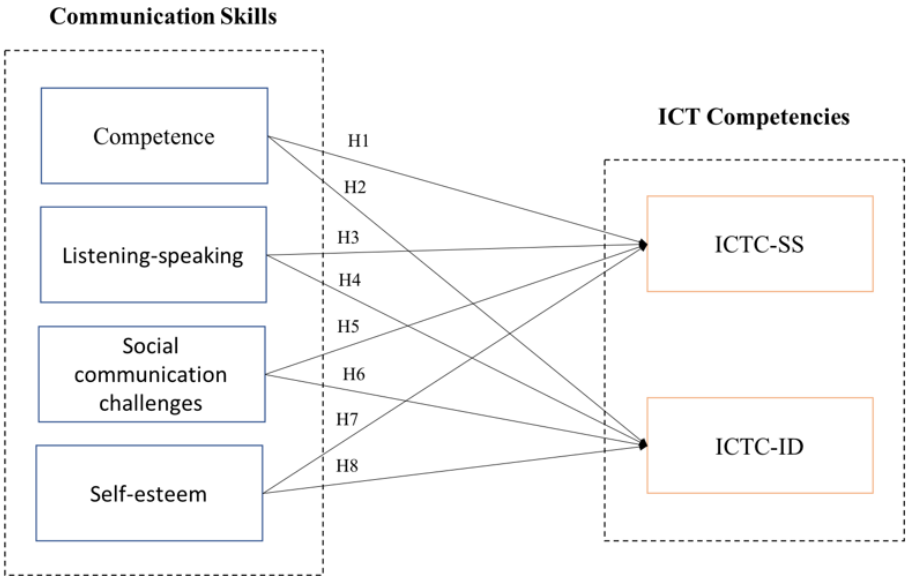

Figure 1. Theoretical model related to effect of communication skills on ICTCs (Source: Authors)

communication skills and ICT literacy remains empirically unexplored. This study aims to address this gap by investigating whether and how pre-service teachers' communication skills are related to their ICT literacy. The findings could provide valuable insights into whether the simultaneous development of both sets of skills is imperative in teacher preparation programs that seek to cultivate digitally literate educators. Overall, this study is significant as it explores an under-researched yet important area that could inform pre-service teacher education.

METHODOLOGY

This study utilized a combination of inferential statistical methods to analyze the relationship between communication skills and ICTCs. The quantitative approach was preferred in the study. The theoretical model presented in **Figure 1** has been tested. Based on this, the following hypotheses have been developed:

- **H1.** The competence sub-dimension of communication skills has an effect on the use of ICT to support students (ICTC-SS).
- **H2.** The competence sub-dimension of communication skills has an effect on the use of ICT for instructional design (ICTC-ID).
- **H3.** The listening and speaking sub-dimension of communication skills has an effect on use of ICTC-SS.
- **H4.** The listening and speaking sub-dimension of communication skills has an effect on use of ICTC-ID.
- **H5.** The social communication challenge (SCC) sub-dimension of communication skills has an effect on the use of ICTC-SS.
- **H6.** SCC sub-dimension of communication skills has an effect on the use of ICTC-ID.
- **H7.** The self- esteem sub-dimension of communication skills has an effect on the use of ICTC-SS.
- **H8.** The self- esteem sub-dimension of communication skills has an effect on the use of ICTC-ID.

The other research question is to determine whether these relationships change according to the genders and departments of the students.

Sample

The participants of the study are pre-service teacher attending Kazan-Federal University and pedagogical faculty. The sample size is 324 students without missing data, which enabled a comprehensive examination of the population of interest. Out of the total participants, 203 (62.7%) were identified as female, whereas 121 (37.3%) were identified as male. The department code was analyzed using the same frequency analysis method. This variable distinguished between 'social science' and 'science' departments.

The frequency analysis revealed that 120 individuals (37.0%) belonged to the social science department, while the remaining 204 individuals (63.0%) were part of the science department, accounting for a cumulative percentage of 100%. The mean age was determined to be 20 years, which was also confirmed as the median age. To measure the variability of ages in the sample, the standard deviation was calculated to be 2.03 years. The age range in the sample was from 17 years (minimum) to 34 years (maximum).

Data Collection Tools

Communication skills scale

The scale used in the study is adapted to Russian context (Salikhova et al., 2023). Initially, the scales are translated into Russian by a bilingual expert, a process known as translation and back-translation. Following this, another bilingual expert translates them back into the original language to ensure the accuracy and equivalence of the translation. Finally, validation of the adapted scales is conducted using statistical methods (exploratory factor analysis [EFA] and CFA). The scale is a four-factor model consisting of 35 items. The four factors are: competence, listening-speaking, SCCs, and self-esteem. The validity and reliability of the scale were assessed through EFA and CFA. EFA resulted in a four-factor structure with factor loadings ranging from .409 to .823, and these four factors explained 58.9% of the total variance. Cronbach's α for the total scale was calculated as .922, indicating high internal consistency. CFA was conducted on a sample of 207 individuals and the final model demonstrated an adequate fit, with statistically significant factor loadings for all indicators. This suggests that the four-factor model, with the applied modifications, is a valid representation of the underlying structure in the data. The composite reliability calculated for each factor using McDonald's ω are .916 for competence factor, .911 for listening-speaking, .928 for SCCs, .909 for self-esteem, and .924 for total scale. The scale consists of 35 items and four factors. The answers given by the participants to each question were coded as 1-5 and for reverse items as 5-1. Points were collected in the related questions to determine the levels for each dimension.

Pre-service teachers' information & communication technology competencies scale

"Information and communication technologies (ICT) competencies scale of pre-service teachers" was employed in the study. It was first created in 2017 by Tondeur et al. (2017) and adapted to the Russian context (Zhdanov et al., 2023). To validate the language used, this study followed Beaton et al. (2000) and Wild et al. (2005) guidelines for translating and culturally adapting measurement tools. Initially, a group of bilingual linguists (group A) translated the scale from English to Russian, reaching a consensus on the most accurate version after discussion. Then, a different group of linguists (group B) back-translated it to English for comparison, ensuring meaning and intent remained intact. Following this, experts (group C) with PhDs in ICT and pedagogy reviewed the translated scale for accuracy in expressions and technical terms. The scale was then pilot-tested on 15 individuals similar to the target population, helping to assess the clarity and comprehensibility of the items. The scale consists of two dimensions. ICTC-SS and ICTC-ID of the first-dimension preservice teachers. Reliability analyzes were calculated. Cronbach's α value for ICTC-SS is 0.979 and McDonald's ω value is 0.973. Cronbach's α value for ICTC-SS is 0.957 and McDonald's ω value is 0.957. Cronbach's α value for the overall scale is 0.980 and McDonald's ω value is 0.978. Generally, Cronbach's α and McDonald's ω values above 0.7 are considered reliable.

Data Analysis

Before the analysis, skewness and Kurtosis values were checked to determine whether the data had a normal distribution. When dealing with sample sizes larger than 300, it's advisable to focus on the histograms and the absolute values of skewness and kurtosis, rather than placing emphasis on z-values. If the absolute value of skewness exceeds two or the absolute value of kurtosis (proper) is over seven, this can indicate a significant deviation from normality (Kim, 2013). When the values given in **Table 1** are examined, it can be stated that the measurements have a normal distribution. The data was analyzed using structural equation modeling (SEM) to examine the relationships between latent variables. Competence, self- esteem, SCC, listening-speaking, and observed variables: ICTC-SS and ICTC-ID. SEM is a robust statistical technique that enables the testing of complex relationships between observed and latent variables. Before assessing the structural model, a CFA was performed to confirm the validity of the measurement model. The results

Table 1. Skewness & Kurtosis coefficients

Dimension	Skewness	Standard error	Kurtosis	Standard error
Competence	-0.1719	0.135	0.1819	0.270
Self-esteem	0.6148	0.135	0.0433	0.270
Social communication challenge	0.8159	0.135	0.6435	0.270
Listening speaking	-1.1674	0.135	2.3942	0.270
ICTC-SS	-0.2463	0.135	-0.1161	0.270
ICTC-ID	0.0431	0.135	-0.1919	0.270

Table 2. Mean of each dimension

Dimension	n	Mean	Standard deviation
Competence	324	3.71	0.717
Self-esteem	324	2.49	0.981
Social communication challenge	324	2.36	0.876
Listening speaking	324	3.85	0.737
ICTC-SS	324	3.45	0.967
ICTC-ID	324	3.31	0.946

Table 3. Model fit indices

Chi-square/df	CFI	TLI	SRMR	RMSEA	RMSEA %90 lower	RMSEA %90 upper
1.757	0.924	0.919	0.057	0.054	0.05	0.057

revealed a satisfactory fit of the measurement model to the data, confirming that the observed variables adequately measure their respective latent constructs. Next, we examined the structural model to determine the relationships between the latent variables. To explore potential gender and departments differences, the data was split into subgroups and SEM analysis was repeated. RStudio and lavaan package were used for analysis.

FINDINGS

In the sample of 324 participants (as shown **Table 2**), the mean score for competence was 3.71 with a standard deviation of 0.717, indicating a moderate level of perceived competence with little variability. The Self measure had a lower mean score of 2.49 with a larger standard deviation of 0.981, signifying more variability in self-perceptions. SCC had the lowest mean score at 2.36 and a standard deviation of 0.876, suggesting that respondents generally reported lower levels of this construct, with some variability. LI-S measure had the highest mean score of 3.85, with a standard deviation of 0.737, meaning respondents perceived a relatively high level of this construct with minimal variability. ICTC-SS and ICTC-ID had mean scores of 3.45 and 3.31 with standard deviations of 0.967 and 0.946, respectively, indicating moderate levels of these constructs with some variability.

Prior to evaluating the structural model, a CFA was conducted to establish the validity of the measurement model.

Chi-square/df ratio for the model is 1.757, suggesting a good model fit as the value is less than three (**Table 3**). Comparative fit index (CFI) and the Tucker-Lewis index (TLI) are 0.924 and 0.919, respectively, indicating a reasonably good fit, although they are slightly below the ideal threshold of 0.95. Standardized root mean square residual (SRMR) is 0.057, which is less than the acceptable limit of 0.08, suggesting a good fit. Root mean square error of approximation (RMSEA) is 0.054, with a 90% confidence interval ranging from 0.05 to 0.057, all of which are below the cutoff of 0.06 for a good fit. Overall, the model fit indices suggest that the model fits the data well.

The results, as shown in **Table 4**, indicate that all item loadings on their respective latent variables are statistically significant, with all p-values being less than 0.001, and the loadings range from 0.451 to 1.021. This signifies that each observed variable reliably measures its corresponding latent construct. More specifically, for the latent variable Competence, the observed variables CSS_1 to CSS_12 have loadings ranging from 0.451 (CSS_3) to 0.785 (CSS_4), demonstrating that these items are good indicators of the COMP construct.

Table 4. Factor Loading for each dimension

Variables	Estimate (=~)	Standard error	z-value	P(>|z|)
COMP				
CSS_1	0.716	0.055	12.944	0
CSS_2	0.783	0.048	16.267	0
CSS_3	0.451	0.053	8.461	0
CSS_4	0.785	0.044	17.786	0
CSS_5	0.764	0.047	16.191	0
CSS_6	0.559	0.050	11.146	0
CSS_7	0.674	0.040	16.821	0
CSS_8	0.756	0.041	18.579	0
CSS_9	0.760	0.040	18.779	0
CSS_10	0.666	0.042	15.999	0
CSS_11	0.630	0.051	12.326	0
CSS_12	0.704	0.048	14.763	0
SELF				
CSS_13	0.856	0.060	14.291	0
CSS_14	0.935	0.053	17.556	0
CSS_15	1.008	0.050	20.157	0
CSS_16	0.994	0.050	19.803	0
CSS_17	1.021	0.046	21.978	0
CSS_18	0.793	0.056	14.255	0
SCC				
CSS_19	0.805	0.063	12.736	0
CSS_20	0.736	0.061	12.074	0
CSS_21	0.880	0.049	17.903	0
CSS_22	0.956	0.049	19.322	0
CSS_23	0.84	0.062	13.614	0
CSS_24	0.981	0.054	18.149	0
CSS_25	0.874	0.054	16.267	0
CSS_31	0.544	0.071	7.620	0
LI-S				
CSS_27	0.743	0.052	14.262	0
CSS_28	0.689	0.059	11.724	0
CSS_29	0.635	0.062	10.285	0
CSS_30	0.694	0.059	11.718	0
CSS_32	0.582	0.064	9.099	0
CSS_33	0.706	0.059	11.947	0
CSS_34	0.751	0.055	13.688	0
CSS_35	0.706	0.059	11.877	0
CSS_36	0.720	0.062	11.653	0
ICTC-SS				
ICTCS_1	0.823	0.052	15.830	0
ICTCS_3	0.842	0.051	16.469	0
ICTCS_4	0.863	0.050	17.220	0
ICTCS_5	0.906	0.049	18.400	0
ICTCS_6	0.930	0.046	20.351	0
ICTCS_7	0.944	0.044	21.219	0
ICTCS_8	0.935	0.045	20.956	0
ICTCS_9	0.907	0.045	20.074	0
ICTCS_10	0.794	0.052	15.261	0
ICTC-ID				
ICTCS_2	0.736	0.052	14.056	0
ICTCS_13	0.870	0.044	19.866	0
ICTCS_14	0.842	0.043	19.417	0
ICTCS_15	0.823	0.051	16.160	0
ICTCS_16	0.840	0.050	16.856	0
ICTCS_17	0.847	0.047	18.190	0
ICTCS_18	0.891	0.043	20.595	0
ICTCS_19	0.897	0.045	20.109	0

Table 5. Structural equation model result

Variables	Estimate (~)	Standard error	z-value	P(>|z|)
ICTC-SS				
COMP	0.465	0.085	5.470	0.000
SELF	-0.053	0.114	-0.464	0.642
SCC	0.194	0.119	1.630	0.103
LI-S	-0.109	0.087	-1.254	0.210
ICTC-ID				
COMP	0.514	0.085	6.049	0.000
SELF	-0.040	0.114	-0.351	0.725
SCC	0.261	0.124	2.098	0.036
LI-S	-0.143	0.085	-1.676	0.094

For the self-esteem construct, items CSS_13 to CSS_18 have loadings ranging from 0.793 (CSS_18) to 1.021 (CSS_17), indicating that these items are strong indicators of self-esteem. In the case of SCC, the loadings for CSS_19 to CSS_25, and CSS_31 range from 0.544 (CSS_31) to 0.981 (CSS_24), again showing that these items reliably measure the SCC construct. For listening speaking, items CSS_27 to CSS_30 and CSS_32 to CSS_36 have loadings from 0.582 (CSS_32) to 0.751 (CSS_34), meaning they are good indicators of the listening and speaking construct. For ICTC-SS, the loadings for items ICTCS_1 to ICTCS_10 range from 0.794 (ICTCS_10) to 0.944 (ICTCS_7), proving that they reliably measure ICTC-SS construct. Lastly, for ICTC-ID, the loadings of items ICTCS_2, ICTCS_13 to ICTCS_19 range from 0.736 (ICTCS_2) to 0.897 (ICTCS_19), demonstrating that these items are valid indicators of ICTC-ID construct. The model shows a strong relationship between the observed variables and their respective latent constructs, indicating a good measurement model fit.

Table 5 is showing the results of an SEM. Competence for communication skills (COMP): There is a statistically significant positive relationship with ICTC-SS (estimate=0.465, p<0.001). This result supports **H1** hypothesis "the competence sub-dimension of communication skills has an effect on the use of ICTC-SS". Self-efficacy for communication skills (SELF): There is no statistically significant relationship with ICTC-SS (estimate=-0.053, p=0.642). This suggests that SELF does not significantly influence ICTC-SS. It means that **H7** hypothesis "the self-esteem sub-dimension of communication skills has an effect on the use of ICTC-SS." is not supported. Communication skills in SCC: There is no statistically significant relationship with ICTC-SS (estimate=0.194, p=0.103). This suggests that SCC does not significantly influence ICTC-SS. **H5** hypothesis "SCC sub-dimension of communication skills has an effect on the use of ICTC-SS." is not supported. Communication skills in listening and speaking (LI-S): There is no statistically significant relationship with ICTC-SS (estimate=-0.109, p=0.21). This suggests that LI-S does not significantly influence ICTC-SS. **H3** hypothesis, "the listening and speaking sub-dimension of communication skills has an effect on the use of ICTC-SS." is not supported.

Competence for communication skills (COMP): There is a statistically significant positive relationship with ICTC-ID (estimate=0.514, p<0.001). This suggests that as COMP increases, ICTC-ID also increases. **H2** hypothesis, "the competence sub-dimension of communication skills has an effect on the use of ICTC-ID." is supported. Self-efficacy for communication skills (SELF): There is no statistically significant relationship with ICTC-ID (estimate=-0.04, p=0.725). This suggests that SELF does not significantly influence ICTC-ID. **H8** hypothesis, "the self-esteem sub-dimension of communication skills has an effect on the use of ICTC-ID." is not supported. Communication skills in SCC: There is a statistically significant positive relationship with ICTC-ID (estimate=0.261, p=0.036). This suggests that as SCC increases, ICTC-ID also increases. **H6** hypothesis, "SCC sub-dimension of communication skills has an effect on the use of ICTC-ID." is supported. Communication skills in listening and speaking (LI-S): There is no statistically significant relationship with ICTC-ID (estimate=-0.143, p=0.094). This suggests that listening-speaking does not significantly influence ICTC-ID. **H4** hypothesis, "the listening and speaking sub-dimension of communication skills has an effect on the use of ICTC-ID." is not supported.

Overall, these findings suggest that COMP significantly influences both ICTC-SS and ICTC-ID. SCC seems to also influence ICTC-ID but not ICTC-SS, while SELF and LI-S do not appear to have a significant influence on either ICTC-SS or ICTC-ID in this model.

Multi-group SEM analysis was performed to determine whether there was a differentiation in influence by gender. According to the analysis results (**Table 6**), for both males and females, COMP is a significant positive

Table 6. Structural equation model result based on gender

Variables	Estimate (~)	Standard error	z-value	P(>|z|)
Female				
ICTC-SS				
COMP	0.356	0.097	3.667	0.000
SELF	-0.209	0.133	-1.565	0.118
SCC	0.347	0.142	2.444	0.015
LI-S	-0.161	0.093	-1.728	0.084
ICTC-ID				
COMP	0.417	0.102	4.100	0.000
SELF	-0.226	0.138	-1.641	0.101
SCC	0.468	0.149	3.135	0.002
LI-S	-0.211	0.097	-2.179	0.029
Male				
ICTC-SS				
COMP	0.620	0.138	4.496	0.00
SELF	-0.005	0.123	-0.038	0.970
SCC	0.160	0.137	1.171	0.242
LI-S	-0.050	0.118	-0.421	0.673
ICTC-ID				
COMP	0.671	0.142	4.744	0.000
SELF	-0.007	0.124	-0.053	0.958
SCC	0.200	0.139	1.443	0.149
LI-S	-0.077	0.119	-0.649	0.516

predictor for both ICTC-SS and ICTC-ID. However, the relationship appears stronger for males (ICTC-SS: 0.62, ICTC-ID: 0.671) than for females (ICTC-SS: 0.356, ICTC-ID: 0.417). This suggests that while COMP is important for both genders, it might be particularly influential for males. There's no significant relationship between self-esteem and either ICTC-SS or ICTC-ID for either gender. It seems self-esteem does not significantly influence these outcomes. For females, there's a significant positive relationship with both ICTC-SS (0.347) and ICTC-ID (0.468), suggesting that females who have better communication skills in SCCs are likely to have higher ICTC-SS and ICTC-ID. For males, however, there's no significant relationship between SCC and either ICTC-SS or ICTC-ID, implying that this variable is less influential for males in this context. There is a significant negative relationship with ICTC-ID for females (-0.211) but not for males, suggesting that for females, as listening-speaking decreases, ICTC-ID increases. This is not observed in males, where no significant relationship exists between listening-speaking and either ICTC-SS or ICTC-ID. In summary, the influence of these communication-related variables on ICTCs (ICTC-SS and ICTC-ID) seems to differ between males and females. COMP is consistently influential for both genders but appears more important for males. SCC plays a significant role for females but not for males. LI_S has a significant, yet negative influence on ICTC-ID for females, but not for males. SELF does not seem to significantly influence either ICTC-SS or ICTC-ID for either gender.

Multi-group SEM analysis was performed to determine whether there was a differentiation in influence by departments (**Table 7**). The COMP appears to be a stronger predictor for both ICTC-SS and ICTC-ID in the science department as compared to the social science department. In the science department, the estimates for COMP are significant ($p<0.001$) and substantially higher (ICTC-SS: 0.537, ICTC-ID: 0.596) than in the social science department, where the estimates are not statistically significant (ICTC-SS: 0.222, $p=0.227$; ICTC-ID: 0.298, $p=0.114$). This suggests that COMP has a greater influence on ICTCs in science than in social science. For both departments, SELF does not appear to be a significant predictor of either ICTC-SS or ICTC-ID, suggesting that the participants' self-esteem regarding communication skills does not play a significant role in their ICTCs, regardless of their department. In the science department, SCC appears to have a positive and significant ($p=0.038$) influence on ICTC-ID (0.246), but not on ICTC-SS. In contrast, in the social science department, SCC does not show a significant effect on either ICTC-SS or ICTC-ID. This might suggest that, particularly for instruction-related ICTCs, dealing with SCCs is more important for those in the science department. LI-S does not significantly predict ICTC-SS or ICTC-ID in either department, suggesting that these particular communication skills do not have a major influence on ICTCs in the context of these departments. In summary, it seems that the influence of these variables on ICTCs varies between departments. COMP has a significant positive influence in the science department but not in the social science department. SCC is only

Table 7. Structural equation model result based on departments

Variables	Estimate (~)	Standard error	z-value	P(>|z|)
Social science				
ICTC-SS				
COMP	0.222	0.184	1.208	0.227
SELF	-0.099	0.144	-0.688	0.491
SCC	-0.017	0.179	-0.097	0.923
LI-S	-0.197	0.129	-1.525	0.127
ICTC-ID				
COMP	0.298	0.189	1.579	0.114
SELF	-0.139	0.147	-0.950	0.342
SCC	0.114	0.183	0.621	0.535
LI-S	-0.208	0.132	-1.585	0.113
Science				
ICTC-SS				
COMP	0.537	0.095	5.670	0.000
SELF	-0.023	0.110	-0.207	0.836
SCC	0.189	0.116	1.628	0.103
LI-S	-0.069	0.091	-0.750	0.453
ICTC-ID				
COMP	0.596	0.098	6.050	0.000
SELF	0.004	0.111	0.032	0.974
SCC	0.246	0.119	2.072	0.038
LI-S	-0.133	0.093	-1.423	0.155

influential for ICTC-ID in the science department. Neither SELF nor LI-S are significant predictors in either department. These findings could guide the design of department-specific ICTC development programs.

DISCUSSION

The findings of the literature review presented above underscore the pivotal role of certain communication skills sub-dimensions in shaping ICTCs among pre-service teachers, as well as their implications on designing effective ICT training programs. The sub-dimension of competence within communication skills appears to play a vital role in the development and exercise of ICTCs, as evident in both ICTC-SS and ICTC-ID elements. Competence aspect of communication skills extends beyond simple capability to express oneself effectively verbally or non-verbally; it is multifaceted, encompassing capacity to comprehend, analyze, and interpret messages in varying contexts (Rateb Darawsheh, 2022; Tarisman & Hanafi, 2020). This understanding and capacity to respond appropriately is likely to enhance pre-service teachers' confidence and effectiveness in utilizing ICT tools for instructional design and student support.

It is plausible that the level of communication competence directly impacts the confidence of pre-service teachers in navigating and implementing ICT tools. When pre-service teachers can effectively communicate, they can more easily understand and apply the information and training they receive in ICT, leading to higher ICTC (Haslaman et al., 2023; Niyazova et al., 2023). Moreover, competence in communication may also assist in peer-to-peer learning, where teachers can share experiences, challenges, and solutions in ICT utilization, creating an atmosphere of collaborative learning that can enhance ICTC (Aslan & Zhu, 2017).

When we consider ICT's role in instructional design, communication competence becomes even more critical. Effective communication is a prerequisite to effectively conveying pedagogical concepts, whether through direct instruction or through the use of ICT tools (Gussen et al., 2023; Kinskey, 2017). Pre-service teachers with high competence in communication can better understand and apply these concepts to instructional design using ICT tools, leading to improved learning experiences for their students. Similarly, in the aspect of student support, the ability to communicate effectively is crucial in explaining complicated concepts, providing constructive feedback, and motivating students (Tinajero et al., 2023; Walker et al., 2022). ICT tools provide various means for this communication, such as online forums, video conferencing, and email. Pre-service teachers who possess high communication competence can effectively use these tools to provide timely and relevant support to students, thereby enhancing the learning process. The intricate relationship between communication competence and ICTCs suggests that strengthening pre-service

teachers' communication skills could subsequently bolster their ICT skills. This correlation underscores the significance of emphasizing and nurturing communication competence in teacher education programs, thus equipping pre-service teachers with tools they need to succeed in a technology-driven educational landscape.

The influence of SCC sub-dimension of communication skills on ICTC-ID element, but not ICTC-SS, is an interesting observation that prompts meaningful discussion. While there is little doubt that all facets of communication skills are vital for pre-service teachers, the specific role of SCC within the context of instructional design offers a unique perspective. SCC encompasses a spectrum of hurdles individuals may encounter in social communication situations, which may include understanding social cues, verbal and non-verbal communication, empathy, and managing interpersonal relationships (Kourmousi et al., 2018; Priadi, 2020). When applied to the context of instructional design, it is plausible to suggest that overcoming SCC may enhance the capability to develop more effective and inclusive instructional materials. Teachers who can navigate these SCCs are likely better equipped to understand and respond to the diverse needs and backgrounds of their students (Sáiz-Manzanares et al., 2021). In turn, they can apply these insights to instructional design, ensuring the creation of materials that resonate with a broad range of students and facilitate an inclusive and effective learning environment (Budoya et al., 2019).

This aspect of SCC could help explain why it may have a more significant role in instructional design, rather than in student support. Designing instruction requires a deep understanding of potential social dynamics among a diverse group of students, whereas student support may involve more one-on-one interactions, where other dimensions of communication skills, such as competence, could have a stronger influence. Furthermore, overcoming SCC may also lead to an increased ability to collaborate with others. The nature of instructional design often requires teamwork among educators (Aslan & Zhu, 2017). Successfully navigating SCCs can enhance collaborative efforts and collective decision-making, which ultimately contributes to more effective instructional design.

In summary, the role of SCC in instructional design underscores the importance of addressing SCCs in teacher training programs. As future educators strive to design more inclusive and effective instruction, their ability to understand and navigate SCCs could become a vital asset. This discussion lends further weight to the argument for a more holistic approach to the development of communication and ICT skills within teacher training programs.

The inconsequential role of self-esteem and listening-speaking sub-dimensions on both ICTC-SS and ICTC-ID is intriguing, considering their traditionally perceived importance in communication (Cameron & Granger, 2019). This could be attributed to the evolving digital context and how technology is leveraged in education. The absence of significant impact from self-esteem might be linked to the impersonal nature of digital communication, potentially minimizing the relevance of personal confidence in successful ICT use (Martin et al., 2020). Also, asynchronous communication common in online learning could reduce self-esteem's traditional role in immediate face-to-face interactions by offering a less pressurized platform for communication (Al Tawil, 2019; Subandowo et al., 2020). The declining significance of listening-speaking skills may result from the shift towards text-based communication in online learning, thus prioritizing skills like text interpretation and digital literacy over traditional speaking and listening (Churchill, 2020)

Nonetheless, these skills remain vital for comprehensive communication proficiency, especially in blended learning scenarios involving some direct interaction (Rodríguez-Abitia & Bribiesca-Correa, 2021). These findings highlight that training programs should not only emphasize traditional communication skills but also promote digital literacy and written communication skills, preparing pre-service teachers for the digitally intensive educational landscape.

The finding that competence for communication skills (COMP) is a significant positive predictor for both ICTC-SS and ICTC-ID for both genders, but more so for males, aligns with some previous research. For instance, a study (Suana, 2018) found that men tend to have higher computer self-efficacy and more positive attitudes towards computers than women. This could potentially explain the stronger relationship observed for males in our study. However, it's important to note that this is a complex issue and other studies have found no gender differences in computer self-efficacy (Guillén-Gámez et al., 2019; Yu & Deng, 2022).

The finding that self-esteem does not significantly influence ICTC-SS or ICTC-ID for either gender is somewhat surprising, as self-esteem has been linked to academic performance and motivation in general

(Orth & Robins, 2022). However, it's possible that in the specific context of ICTCs, other factors (like COMP and SCC) play a more prominent role.

The finding that COMP has a greater influence on ICTCs in science than in social science is intriguing. It could be related to the nature of the disciplines. Science often requires more direct interaction with technology and data analysis, which could make communication skills particularly important. This aligns with research suggesting that discipline-specific factors can influence ICTCs (de Silva & Costa, 2022; Soroya et al., 2021).

The finding that SCC plays a significant role for females and for the science department but not for males or the social science department is also interesting. It suggests that the ability to navigate SCCs is particularly important in certain contexts. This aligns with research highlighting the importance of social skills in collaborative learning environments, which are common in science education (Agosto et al., 2013; Hussin et al., 2019).

In essence, the discussion synthesizes key insights from the reviewed literature on the influence of various communication skills on ICTC-SS and ICTC-ID. It emphasizes the importance of competence in ICT use and overcoming SCCs, given their significant impact on both ICTC-SS and ICTC-ID. The hands-on training approach for pre-service teachers and encouragement of effective online interaction were identified as crucial strategies for developing these skills. Conversely, traditional communication skills such as self-esteem and listening-speaking, despite their established role in effective communication, showed less influence on ICTCs. This led to the proposal of a balanced training strategy that, while prioritizing ICT-related skills, still values these traditional communication aspects as part of a comprehensive skill set. Ultimately, the discussion underscores the need for a holistic, nuanced approach to ICT training. This approach should aim to equip pre-service teachers with a robust blend of skills to effectively navigate and contribute to the increasingly complex and digital educational landscape.

CONCLUSIONS

This study aimed to investigate the effects of different dimensions of communication skills, including COMP, SELF, SCC, and LI-S on the utilization of ICTC-SS and ICTC-ID. Our findings provide critical insights into the relationship between these constructs. The results show that participants' perceived competence in communication skills plays a significant role in their ICTC-SS and ICTC-ID, supporting **H1** and **H2** hypotheses. This indicates that as participants felt more competent in their communication skills, they were better able to utilize ICT in their teaching practice, whether in supporting students or designing instructions. This relationship suggests the need to enhance and focus on competence in communication skills training for educators to maximize their ICT utilizations in the classroom. The results, however, showed that self-esteem in communication skills and listening-speaking communication skills did not significantly impact ICTCs, either for student support or instructional design, leading to the rejection of **H3**, **H4**, **H7**, and **H8** hypotheses. This implies that the confidence an educator has in their communication skills or their ability in listening and speaking did not necessarily translate into more effective use of ICT in educational settings. Interestingly, communication skills in addressing SCCs showed a positive relationship with ICTCs in instructional design, supporting **H6** hypothesis, but had no significant impact on ICTCs for student support, rejecting **H5** hypothesis. This suggests that educators' ability to manage SCCs may contribute to their ICTCs in instructional design, but not in student support. This finding points to the complex nature of using ICT in educational settings, where different communication skills might affect different areas of ICT utilization. The implications of this study could guide future professional development programs by emphasizing the significance of competence in communication skills and the ability to handle SCCs for educators to enhance their ICTCs. Nevertheless, as this study was conducted with a specific sample, future research should aim to verify these findings in other populations or educational contexts.

In conclusion, this study has shed light on the integral role of certain dimensions of communication skills in the effective use of ICT in educational settings, offering valuable implications for future research and educational practice. Despite some dimensions of communication skills not showing a significant impact on ICTCs, this should not downplay their overall importance in education. It is important to view these findings

as pieces of a larger puzzle, where all elements of communication skills contribute to a teacher's effectiveness in the classroom.

While this study provides valuable insights, it is not without limitations. The data was collected from a specific sample of pre-service teachers in a particular context. Further research is needed to determine if similar relationships between communication skills and ICTCs would emerge in other samples, such as in-service teachers or those in different geographical regions. In addition, this study utilized self-report measures, which rely on participants' perceptions. Incorporating objective assessments of communication and ICT skills could strengthen the conclusions. There are also many other factors, beyond communication abilities, that can influence ICTC. Future studies could adopt a more comprehensive framework incorporating additional variables. Overall, care should be taken not to over-generalize the findings to all educational settings. However, the study does highlight important connections that can inform teacher training and warrant further investigation. The findings open promising avenues for future research to unpack the nuances in the relationship between communication skills and effective ICT integration among both pre-service and in-service educators. Such research can guide the concurrent development of both competencies in teacher preparation programs seeking to cultivate 21st century teaching excellence.

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