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Research Article

# Evaluation of pre-service teachers' digital skills and ICT competencies in context of the demands of the 21st century

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## ABSTRACT

21st century has seen the emergence of digital skills as a crucial ability with profound effects on employment, education, and social relationships, among other facets of life. The best talents to teach are the subject of study by those who establish educational policies. The goal of this study is to examine the relationship between information and communication technology competency (ICTC) and digital abilities. It focuses on which of the digital skills sub-dimensions has a greater impact on ICTC and how this impact varies by country, age, and gender. This study employed a quantitative research design to evaluate the association between ICTC and various digital skills. The sample group consisted of 620 university students from Russia and Kazakhstan. Digital skills were measured using a scale adapted for the Russian context, while ICTC scale was first adapted for the Russian context following language validity steps. The study also conducted path analysis to determine the impact of ICTC on digital skill dimensions and multigroup path analysis to assess effects according to different independent variables. The study found that certain dimensions of digital skills, specifically "use of digital tools", "communication of digital content", and "creation of digital content", significantly influence ICTC. However, "management of digital content", "digital security", and "digital empathy" dimensions did not show a significant effect. The impact of these dimensions varied significantly across different demographic groups, suggesting that digital skills and ICTC development may differ among these groups. The findings highlight the need for tailored strategies to develop and promote digital skills and ICTC, considering these demographic differences.

**Keywords:** digital skills, ICT competencies, path analysis

## INTRODUCTION

Digital skills have emerged in the 21st century as an essential competency that deeply impacts various aspects of life, including work, education, and social interactions. Education policy developers are conducting studies on which skills should be taught. According to a systematic literature review by van Laar et al. (2020), 21st century skills encompass a broad spectrum that includes technical, knowledge, communication, collaboration, critical thinking, creativity, and problem-solving abilities. The level of these skills among individuals is determined by various factors such as personality, psychological determinants, demographic factors, and socioeconomic status. In the context of education, Siddiq et al. (2016) highlight the role of teachers in emphasizing the development of students' digital knowledge and communication skills. In this context, it is stated that teachers' personal beliefs and the use of information and communication technology (ICT) are important. Finally, Kivunja (2014) advocates a pedagogical paradigm shift to emphasize critical thinking and problem-solving skills essential for 21st century learning and professions.

ICT competencies affect many fields such as education, business, and social interactions (Chen et al., 2017). It involves the ability to effectively use and interact with digital technologies, such as understanding their uses, creating relevant content, and critically evaluating digital information (McGarr & McDonagh, 2021). ICT competencies is especially important for teacher and teacher candidates in education (García-Martín & García-Sánchez, 2017; Gómez-Trigueros et al., 2019). Studies (Guillén-Gámez et al., 2019; Huda et al., 2018) have shown that pre-service teachers' (PST) views about information and communication technology competency (ICTC) can influence how they will use these technologies in their classes. In addition, the development of ICTC includes technical skills as well as problem-solving and critical thinking skills (Aslan & Zhu, 2017). The importance of these skills in teacher training is becoming increasingly understood. Despite the growing importance of ICTC, research (Tondeur et al., 2018) suggests that ICT training should be further integrated into teacher training programs.

It is important to define the terms of digital skills before establishing their extent. Skills are related to knowledge and can be either physical or mental, i.e., a person's capacity to carry out a certain activity (de Silva & Costa, 2022). According to van Laar et al. (2020), digital skills are the ability to comprehend, use, and build technical tools. In order to develop their skills, adapt to technological advancements, and produce digital solutions, people need to acquire digital skills in the field of technology, which is one of the fastest expanding industries of our day (Hatos et al., 2022).

Digital security (Rojo-Ramos et al., 2020) digital research and learning (Brown et al., 2021), and digital content production (Toto & Limone, 2021) are some of the key aspects of these talents. One of the most crucial elements of the digital revolution of education is addressing digital skills in the context of instructors (Díaz et al., 2021). To provide students the skills they need for the digital era, to build successful learning environments, and to enhance the learning process, it is crucial for instructors to possess digital skills (Siddiq et al., 2016). For instance, accessing, analyzing, and interpreting information in digital settings are all part of a teacher's digital literacy competency (Abbasova et al., 2021). This ability aids the instructor in selecting online resources with care, presenting suitable digital materials to pupils, and fostering students' digital literacy abilities (Antonietti et al., 2022). On the other hand, instructors may instruct students on how to conduct themselves securely and morally in digital contexts thanks to their knowledge of digital ethics and security (Vajen et al., 2023). Therefore, fostering digital transformation in education and preparing students for the digital era depends heavily on instructors possessing digital skills.

In today's technology-driven society, digital skills and ICTC are two connected notions that are crucial (de Silva & Costa, 2022; Manco-Chavez et al., 2020). According to Falloon (2020), "digital skills" are the abilities needed to use digital tools, programs, and platforms successfully. These abilities include a spectrum of competencies, from simple ones like operating a computer or smartphone (Braslauskienė et al., 2017; Huda et al., 2018) to more complex ones like programming or digital marketing (Chen et al., 2017; Kumara, 2020). On the other hand, ICTC is a larger notion that covers both digital skills and an awareness of how to use digital technology ethically and successfully in a range of situations, including the workplace, classroom, and daily life (McGarr & McDonagh, 2021; Tondeur et al., 2017). ICTC and digital skills are interdependent and have an impact on one another (Fan & Wang, 2022; Mirķe et al., 2019; Youssef et al., 2022). ICTC is built on the technical knowledge required to operate digital tools and technologies, which is provided through digital skills (Ahmad

et al., 2013; Chen et al., 2017). To present ICTC (Le et al., 2019) without digital skills would be difficult. In contrast, ICTC fosters the development of digital skills and contextualizes them (Martzoukou et al., 2021).

It involves not just understanding how to utilize digital technologies but also when, why, and the ramifications of doing so (Kaarakainen et al., 2018). For instance, a person with a high ICTC not only understands how to utilize social media (a digital skill), but also how to do it safely and ethically, as well as how it may affect their privacy and mental health. The latter idea is therefore more comprehensive and holistic, incorporating not only technical skills but also critical thinking and ethical issues connected to digital technology, even if digital skills are a major component of ICTC. Digital security and empathy play crucial roles in the digital environment (Braun et al., 2019; Merchan-Lima et al., 2021; Terry & Cain, 2016). Digital security includes practices and measures taken to reduce risks and threats in the digital space, such as cyberbullying, identity theft, and data breaches (Merchan-Lima et al., 2021). Empathy, on the other hand, is the ability to understand and share the feelings of others, necessary to nurture positive interactions and relationships in the digital environment. Digital empathy helps to create a more positive and supportive online environment. It can also help to reduce cyberbullying and other negative online behaviors (Braun et al., 2019).

In the 21st century, instructors must have the ability to create and use digital content. These abilities include the capacity to design, adapt, and apply digital materials to improve teaching and learning processes. The use of instructional software, running online classrooms, and incorporating multimedia materials into classes are a few of them. The usage of Web 2.0 services in higher education has the potential to revolutionize the processes of learning and teaching, claim Torres Kompen et al. (2019). This shows that educators who are proficient in developing and utilizing digital content can give their pupils more individualized and interesting learning opportunities. Ata and Yildirim's (2019) further underline the significance of these abilities. The researchers discovered that although PSTs had favorable opinions of digital literacy, they lacked the sophisticated cognitive abilities needed to locate, assess, produce, and share digital content. This underlines the necessity for educators to acquire these abilities to successfully use the digital world for instruction and learning. Teachers must have the ability to create and use digital material because doing so will allow them to use digital tools and resources to improve student learning, engagement, and outcomes. These abilities also equip educators with the tools they need to adapt to the rapidly changing educational digital ecosystem.

Information and communication technology (ICT) competences and digital literacy are crucial for instructors working with various demographics and cultures. Regardless of the cultural or demographic context, these abilities allow instructors to utilize digital tools and technology to improve their teaching and learning experiences (van Laar et al., 2017). ICT competences and digital abilities can support instructors in helping students with a variety of learning needs and learning styles (Ally, 2019). For instance, teachers can adapt learning activities and resources to each student's requirements by using digital technologies to deliver differentiated education. This is particularly crucial in classrooms with a diverse student population because students may come from various language, cultural, and educational backgrounds (Bhattarai, 2019). Additionally, collaboration and understanding across cultural boundaries can be facilitated by digital skills and ICT competences (Shonfeld et al., 2021). By connecting their pupils with classmates from many cultures via digital platforms, teachers may promote intercultural communication and collaboration. To further develop students' cultural knowledge and global awareness, digital technologies may also be utilized to access and study a variety of cultural resources, such as digital libraries, museums, and databases (Gutiérrez-Esteban et al., 2016). The efficient use of digital tools and technology in various cultural contexts does, however, need cultural competency (Shonfeld et al., 2021). According to Karaseva et al. (2015), teachers should be aware of and attentive to cultural variations in technology use and digital communication norms. As not all students may have the same amount of access to digital technology, they should also take these challenges into account (Willems et al., 2019).

As a result, instructors working with diverse communities and cultures need to be proficient in digital skills and ICT. Along with improving teaching and learning opportunities, it also promotes collaboration and understanding across cultural boundaries. To promote inclusive and successful digital learning experiences for all students, these abilities must be reinforced by a dedication to cultural competency and digital equality.

The purpose of this research is to examine relationship between digital skills and ICTC. It focuses on which of sub-dimensions of digital skills affects ICTC more and how this effect differs by country, age, and gender.

**Table 1.** Reliability of digital skills dimensions

| Dimension | Cronbach's alpha | McDonald's omega |
|---|---|---|
| Management of digital content | .959 | .961 |
| Digital empathy | .951 | .952 |
| Use of digital means | .939 | .939 |
| Digital safety | .941 | .942 |
| Communication of digital content | .954 | .955 |
| Creation of digital content | .907 | .907 |

### Research Questions

1. Is there a relationship between digital skills and ICTC?
2. Which sub-dimensions of digital skills affect ICTC more?
3. Does the impact of the sub-dimensions of digital skills differ according to country, age and gender?

Digital skills and ICTC are vital to the success of individuals and societies in today's technology-driven world. This research can help us understand how digital skills and ICTC interact with each other and how this interaction varies according to demographic factors. This information can assist in the development of education policies and programs, and in identifying strategies for improving teachers' and students' digital skills and ICTCs. Furthermore, this research can deepen our understanding of how digital skills and ICTC can play a role in reducing social inequalities.

## METHODOLOGY

To experimentally evaluate the association between ICTC and various characteristics of digital abilities, this study used a quantitative research design (Creswell & Plano Clark, 2011). The systematic empirical exploration of observable phenomena using statistical, mathematical, or computational approaches is a component of quantitative research design. This method enables quantitative examination of data that has been collected and provides for objective assessment, giving the study an organized and exacting framework (Given, 2008).

### Sample

The sample group was applied to Universities in Kazakhstan and Russia. After the data was cleared, 620 students remained. The Russian group consists of 524 people and the Kazakhstan group consists of 96 people. When the participants are examined according to age groups, the 18-19 age group is 51.3%, the 20-21 age group is 25.0%, and the over 22 age group is 23.7%. In terms of gender, while the rate of women is 63.4%, the rate of men is 36.6%.

### Data Collection Tools

#### *Digital skills scale*

The scale format adapted in the Russian context by Kryukova et al. (2022) was used to measure digital skills. According to the authors, the scale consists of 25 questions and six dimensions. The dimensions of the scale are named as "management of digital content (MDC)", "digital empathy", "using digital media", "digital safety (DS)", "communication of digital content (CDC)" and "creation of digital content". Cronbach's alpha (α) and McDonald's omega (ω) were calculated for each dimension (**Table 1**).

#### *ICT competencies scale*

For ICTC scale, the scale (Tondeur et al., 2017) used in the study was preferred. Since the scale was not adapted in the Russian context, the study was first adapted. To ensure language validity, the study followed the steps suggested by Beaton et al. (2000). Initially, two linguists translated the scale from English to Russian, and after comparing the translations, they reached a consensus. Subsequently, back-translation was performed, with two different linguists translating the scale from Russian to English. With the translations deemed equivalent, the scale was reviewed by four experts in the field of social media use, each holding a Ph.D. They examined the questions for the correctness of expressions and technical terms. The validity and reliability study were applied to a similar group that was not from the study group. It was applied to a total of

**Table 2.** Skewness & kurtosis for each variable

| Variables | n | Skewness | Standard error | Kurtosis | Standard error |
|---|---|---|---|---|---|
| ICTC | 620 | -0.175 | 0.0981 | -0.927 | 0.196 |
| Management digital content | 620 | -0.735 | 0.0981 | -0.272 | 0.196 |
| Use digital means | 620 | -0.576 | 0.0981 | -0.389 | 0.196 |
| Communication digital content | 620 | -0.795 | 0.0981 | -0.159 | 0.196 |
| Creation digital content | 620 | -0.557 | 0.0981 | -0.575 | 0.196 |
| Digital safety | 620 | -0.704 | 0.0981 | -0.336 | 0.196 |
| Digital empathy | 620 | -0.679 | 0.0981 | -0.231 | 0.196 |

**Table 3.** General descriptive statistics about scale

| | Mean | Standard deviation | Average Level |
|---|---|---|---|
| ICTC | 3.22 | 1.18 | Moderate |
| Management digital content | 3.86 | 1.02 | High |
| Use digital means | 3.70 | 1.05 | High |
| Communication digital content | 3.93 | 1.05 | High |
| Creation digital content | 3.67 | 1.14 | High |
| Digital safety | 3.83 | 1.04 | High |
| Digital empathy | 3.79 | 1.05 | High |

358 students in Russia. It is randomly allocated at a rate of 40.0%-60.0%. There were 136 people in the first group and EFA analysis was applied. Bartlett's test of sphericity: $\chi^2$=3,862, df=171 and p<.001 and KMO .955. It shows that the data are suitable for EFA analysis. 'Maximum likelihood' extraction method was used in combination with a ProMax rotation. The factor loads of the items vary between .936 and .686. A single factor structure was obtained. To check the accuracy of this structure, CFA analysis was performed on the second sample (222). Calculated as $\chi^2$/df=2.73, CFI=.968, TLI=.957, SRMR=.0215, and RMSEA=.0883. Since $\chi^2$/df<3, CFI and TLI>.90, SRMR and RMSEA<0.8 (Brown, 2015; Hu & Bentler, 1999; Kline, 2016), the single factor structure scale was validated by CFA. The study calculated Cronbach's α (.983) and McDonald's ω (.987) reliability coefficients to assess the scales' reliability.

### Data Analysis

In this study, each dimension's mean score was computed based on respective scale items. Subsequently, the normality of these measurements was examined. Given the substantial sample size exceeding 300, both kurtosis and skewness values were scrutinized, as presented in **Table 2**. These values ranged between -0.175 and -0.927. Based on these statistics, the measurement distributions appear to conform to normality. To ascertain the degree of association between variables, Pearson's correlation calculation was utilized. The investigation further aimed to identify the extent of ICTC effect on digital skill dimensions. For this, path analysis was implemented. Path analysis, a form of multivariate analysis, is instrumental in regulating multiple independent variables when formulating a linear regression model and is particularly suited to scrutinizing intricate relationships amidst numerous variables. In executing the path analysis, the constructed model was initially reviewed. If the model's goodness-of-fit indices, namely comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR), were deemed satisfactory, the next step involved examining the variables' effects. Lastly, multigroup path analysis was undertaken to assess the effects according to distinct independent variables. This allows for the inspection of potential disparities in the relationships across different groups within the sample.

## FINDINGS

**Table 3** presents the means and standard deviations for various measures associated with ICT competency and digital skills. ICTC has an average rating of 3.22 with a standard deviation of 1.18, indicating a moderate level of ICT competence among the participants with some variance in responses. MDC has a higher average score of 3.86 with a standard deviation of 1.02, suggesting that participants generally reported good skills in managing digital content, and the responses were slightly less dispersed than ICTC scores. The use of digital means (UDMs) also showed a reasonably high mean of 3.7 with a standard deviation of 1.05, pointing to a high degree of digital engagement among respondents, again with some variability.

**Table 4.** Correlation coefficient among variables

| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| ICTC (1) | | | | | | |
| Management digital content (2) | 0.462*** | | | | | |
| Use digital means (3) | 0.517*** | 0.767*** | | | | |
| Communication digital content (4) | 0.401*** | 0.782*** | 0.747*** | | | |
| Creation digital content (5) | 0.519*** | 0.774*** | 0.797*** | 0.762*** | | |
| Digital safety (6) | 0.432*** | 0.794*** | 0.731*** | 0.772*** | 0.797*** | |
| Digital empathy (7) | 0.434*** | 0.749*** | 0.676*** | 0.725*** | 0.727*** | 0.779*** |

Note. *p<.05; **p<.01; & ***p<.001

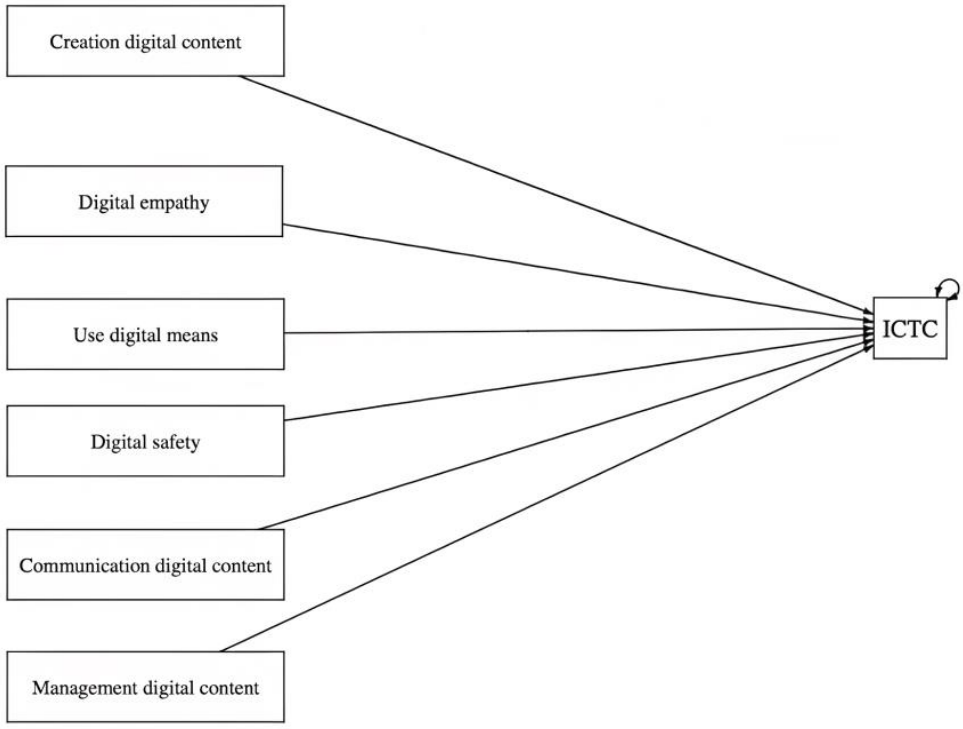



**Figure 1.** Model 1 for path analysis (Source: Authors)

CDC has the highest mean score at 3.93, with a standard deviation of 1.05, indicating that participants reported the highest skills in this area, although there is some variation in the scores. Creation of digital content has a slightly lower mean of 3.67, with a higher standard deviation of 1.14, signifying moderate skills in this area with a wider spread in responses. DS shows a high average rating of 3.83 with a standard deviation of 1.04, implying that participants generally feel safe in the digital environment. Lastly, digital empathy has an average score of 3.79 with a standard deviation of 1.05, signifying a good level of empathetic behavior in the digital sphere among the participants, with some variability in their responses.

Pearson correlation matrix, as shown in **Table 4**, provides a measure of strength and direction of linear relationships between pairs of variables. A positive and significant relationship was obtained between all variables. While the highest correlation with ICTC was between creation digital content, the lowest correlation was with DS. Among the digital skills dimensions, the highest correlation was between creation digital content and use digital means. The lowest correlation is between digital empathy and use digital means.

A series of models were constructed to analyze the relationship between digital skills and ICTC. Initially, model 1, as shown in **Figure 1**, was established to test the assumption that no variable has a moderating effect and influences ICTC directly. In model 1, the highest impact was observed from 'UDMs'. Therefore, in constructing model 2a (**Figure 2**), UDM was assigned a moderating role, and variables 'MDC' and 'DS', which had negligible effects, were associated with this moderator. Subsequently, model 2b (**Figure 2**) was built by eliminating the direct effects of MDC and DS. Later, model 3a (**Figure 3**) was developed, conferring the moderating role to 'CDC', the variable with the greatest effect. Model 3b (**Figure 3**) was then formed by

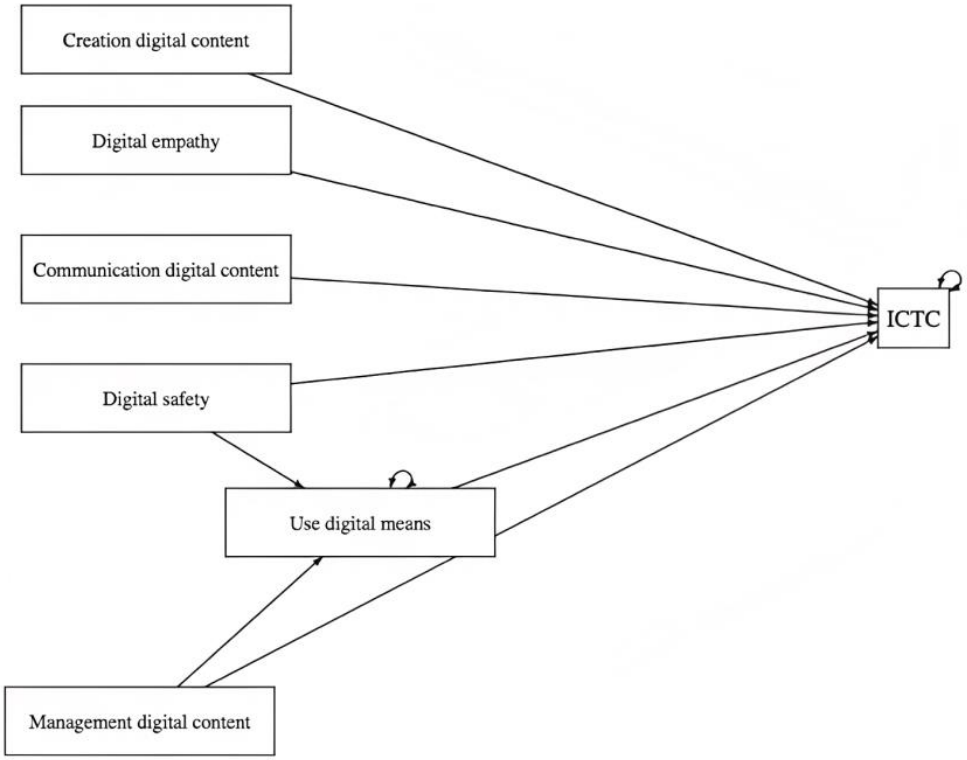



**Figure 2.** Model 2 use digital means is moderator variable (Source: Authors)

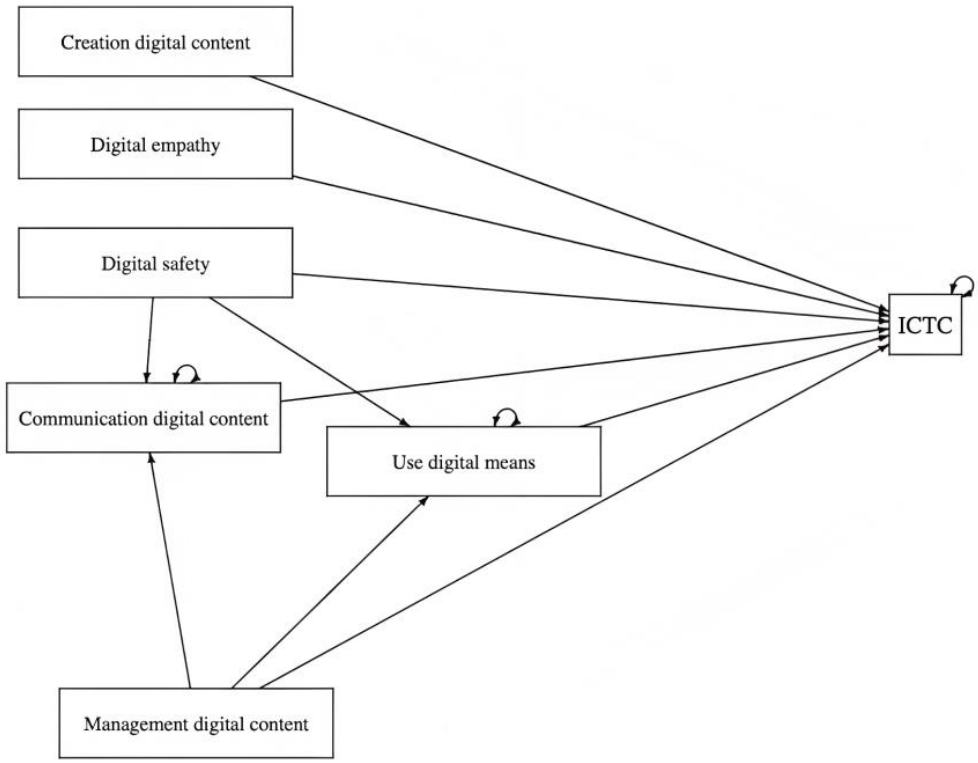



**Figure 3.** Model 3 use digital means & communication digital content are moderator variables (Source: Authors)

removing the direct impacts of MDC and DS. For each model, fit indices were compared to discern the best-fitting model.

**Table 5.** Indices for path analyses models

| Model indices | M1 | M2a | M2b | M3a | M3b |
|---|---|---|---|---|---|
| CFI | 1 | 0.856 | 0.856 | 0.886 | 0.886 |
| TLI | 1 | 0.473 | 0.683 | 0.659 | 0.756 |
| AIC | 1,743.458 | 2,947.921 | 2,947.921 | 4,078.216 | 4,076.393 |
| BIC | 1,774.466 | 2,992.219 | 2,992.219 | 4,135.802 | 4,125.12* |
| SABIC | 1,752.242 | 2,960.470 | 2,960.470 | 4,094.529 | 4,090.197 |
| RMSEA | 0.0 | 0.275 | 0.275 | 0.251 | 0.213 |
| SRMR | 0.0 | 0.036 | 0.036 | 0.041 | 0.042 |

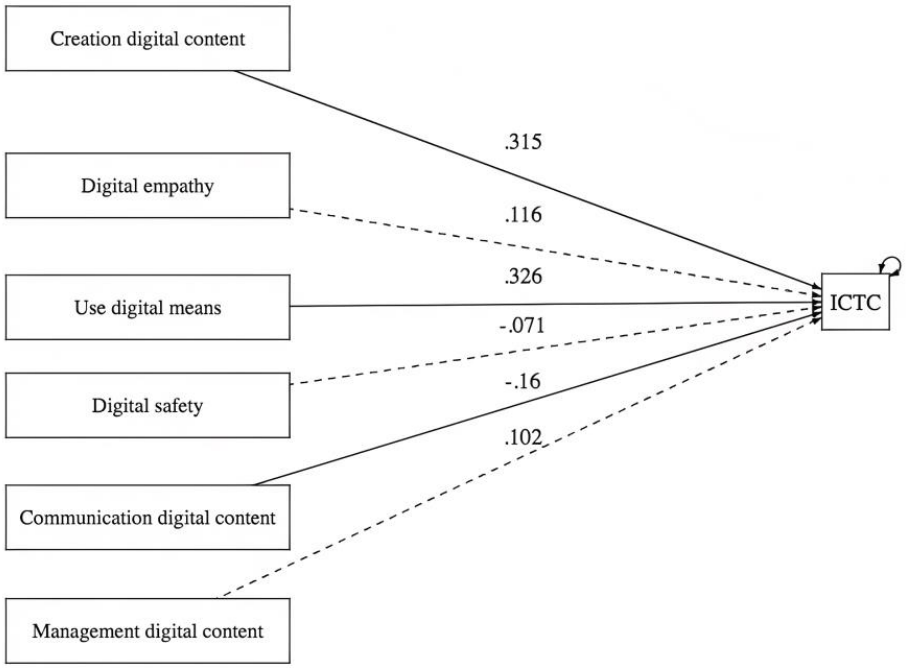



**Figure 4.** Path analysis result for all participants (Source: Authors)

Upon examination of the model fit indices, as shown in **Table 5**, it was established that model 1 achieved a perfect fit because CFI and TLI are over .90 and RMSEA is below .08 and SRMR is below .05. However, for the subsequent models constructed, both the CFI and TLI could not surpass the critical value of .90. Similarly, RMSEA could not fall below the critical threshold of .08. Contrarily, the SRMR for all models was below the critical value of 0.05, signifying good fit. Consequently, it was decided to proceed with further analysis on model 1 in the subsequent stages of the study.

Based on the results of the path analysis (**Figure 4**), it is evident that the dimensions "UDMs", "CDC", and "creation of digital content" have a statistically significant impact on ICTC.

The dimensions of "MDC", "DS", and "digital empathy", on the other hand, do not reach the threshold of statistical significance in their influence. In comparing the magnitude of the effects, the "creation of digital content" dimension exerts the most substantial influence, with an estimated value of 0.357. "UDMs" dimension follows, with an estimate of 0.326. "CDC" dimension, however, exhibits a negative effect with an estimated value of -0.16. Lastly, the R-square value is found to be 0.341, indicating that these dimensions collectively account for 34.1% of the variance in ICTC.

Based on the path analysis, we can observe some significant differences between Russia and Kazakhstan in terms of the impact of various dimensions on ICTC (**Figure 5**). In MDC, for Russia, the estimate value is 0.046 with a p-value of 0.575, indicating no significant relationship. However, for Kazakhstan, the estimate value is 0.416 with a p-value of 0.021, suggesting a significant positive relationship. In UDMs dimension, both countries show a significant positive relationship with ICTC, but the effect is slightly stronger in Russia (estimate: 0.328, p-value: 0.000) compared to Kazakhstan (estimate: 0.265, p-value: 0.044).

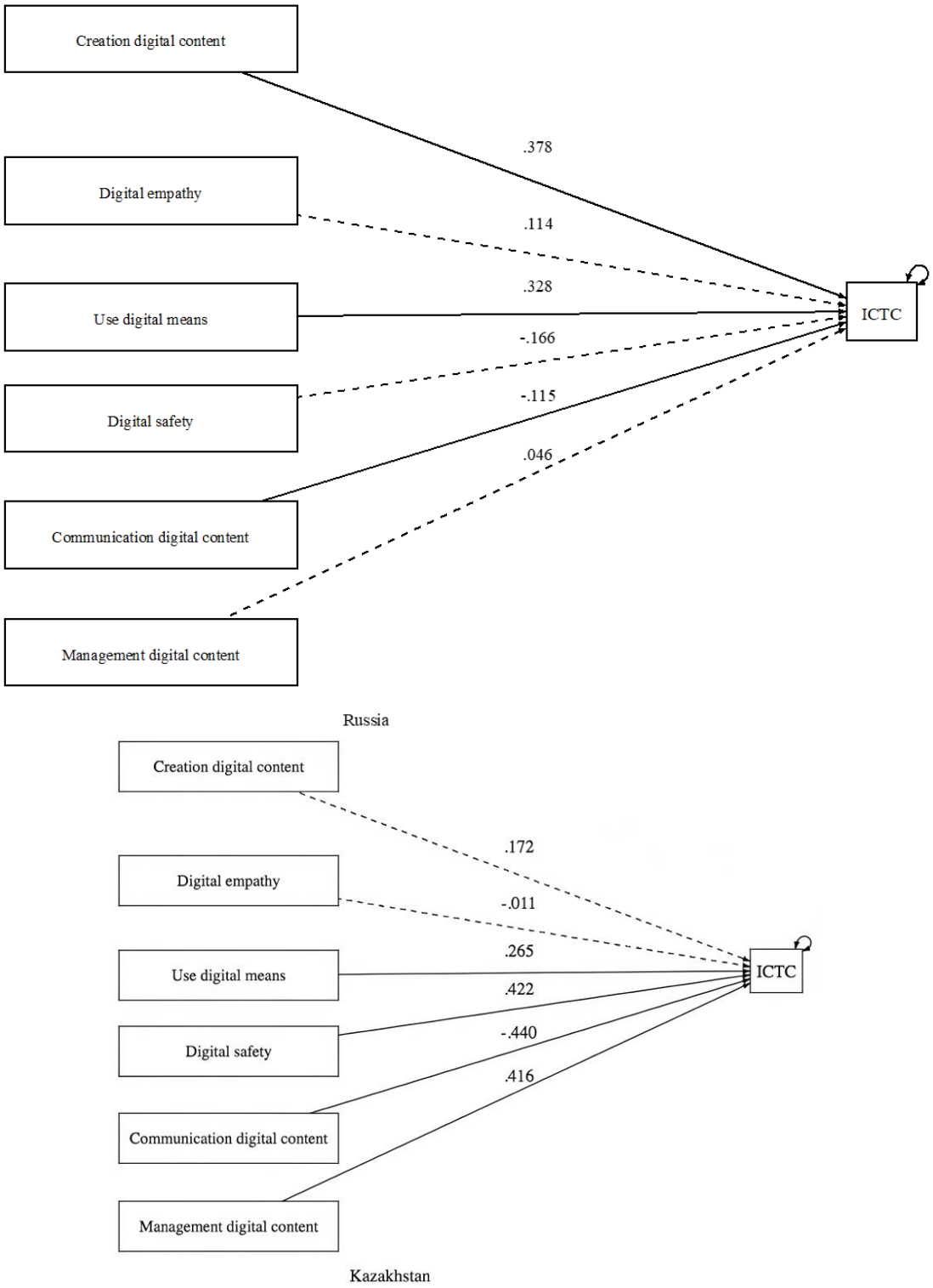



**Figure 5.** Path analysis result based on country (Source: Authors)

In CDC dimension, for Russia, this dimension does not show a significant relationship (estimate: -0.115, p-value: 0.125), whereas for Kazakhstan, it shows a significant negative relationship (estimate: -0.44, p-value: 0.005). In DS dimension, Russia, it shows a significant negative relationship (estimate: -0.166, p-value: 0.046). However, in Kazakhstan, this dimension shows a significant positive relationship with ICTC (estimate: 0.422, p-value: 0.015). In the creation of digital content dimension, Russia shows a significant positive relationship (estimate: 0.378, p-value: 0.000), whereas this dimension is not significant in Kazakhstan (estimate: 0.172, p-value: 0.236). In digital empathy dimension, neither country shows a significant relationship for this

dimension. Lastly, when considering the R-square value, the variability in ICTC is better explained in Kazakhstan (48.7%) as compared to Russia (29.9%). This suggests that these dimensions, as a whole, have a greater explanatory power in Kazakhstan. These results could potentially suggest different priorities and emphasis on different dimensions of ICT competency in the two countries. The differences might also be due to varying societal, economic, or cultural factors affecting acquisition and use of digital skills in two countries.

Path analysis results demonstrate some differences in the impact of various dimensions on ICTC across different age groups (**Figure 6**). MDC dimension does not show a significant relationship with ICTC in the 18-19 and 22-and-over age groups. However, for the 20-21 age group, there's a significant positive relationship (estimate: 0.417, p-value: 0.016). In the use of the digital means dimension, there's a significant positive relationship in the 18-19 age group (estimate: 0.356, p-value: 0.000). However, for the 20-21 age group and the 22-and-over age group, this dimension does not show a significant relationship, though the 22-and-over age group is close to the threshold for statistical significance (estimate: 0.219, p-value: 0.054). In CDC dimension, there's a significant negative relationship in the 18-19 age group (estimate: -0.188, p-value: 0.046) and the 20-21 age group (estimate: -0.389, p-value: 0.01). The 22-and-over age group, however, shows a positive relationship that approaches the threshold of significance (estimate: 0.196, p-value: 0.087). DS dimension does not show a significant relationship with ICTC in any age group. The creation of digital content dimension shows a significant positive relationship with ICTC in the 18-19 age group (estimate: 0.421, p-value: 0.000) and the 22-and-over age group (estimate: 0.236, p-value: 0.032). However, it is not significant in the 20-21 age group. The digital empathy dimension does not show a significant relationship with ICTC in any age group, although it approaches significance in the 22-and-over age group (estimate: 0.177, p-value: 0.065). Lastly, when considering R-square value, variability in ICTC is better explained in the 22-and-over age group (49.1%) as compared to the 18-19 age group (30%) and the 20-21 age group (27.3%). The results indicate that the importance of different dimensions of ICTC can vary across age groups, potentially due to differences in exposure to and experiences with digital content and technology. The older age group (22 and over) appears to have a more complex relationship with these dimensions, as suggested by the higher R-square value.

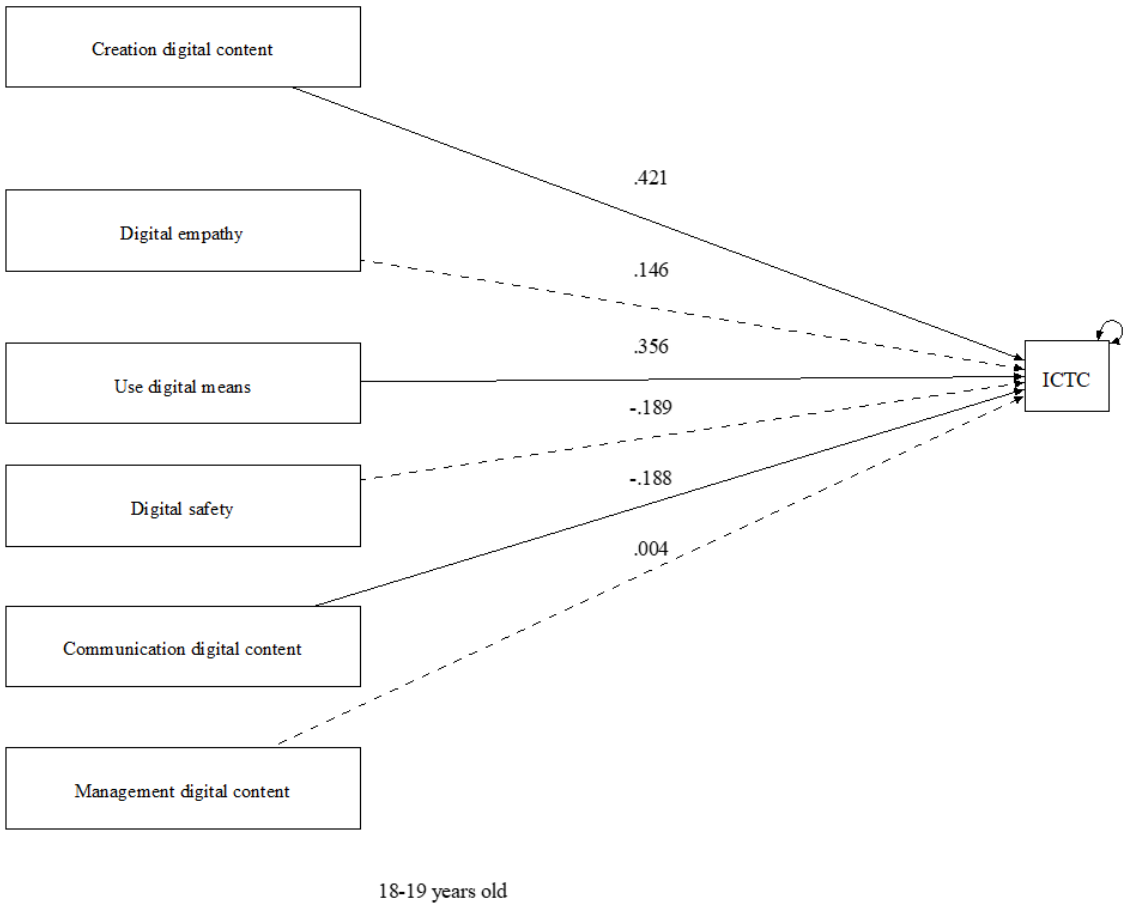
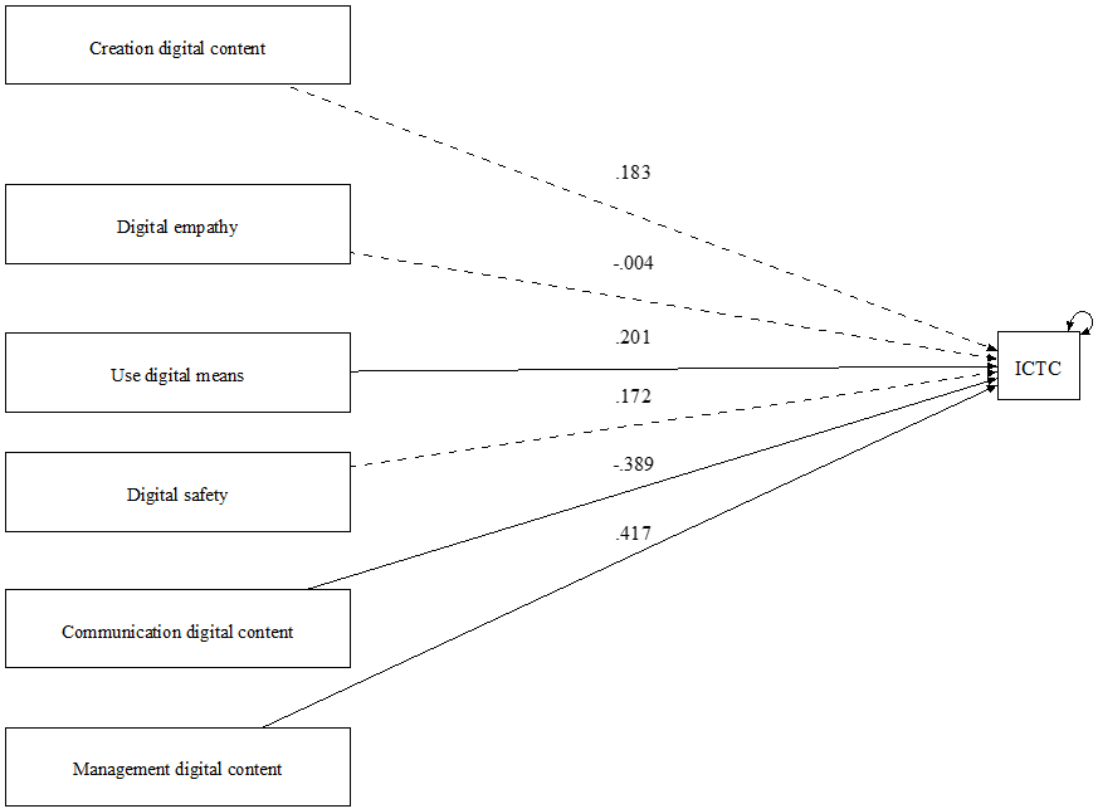



**Figure 6.** Path analysis result based on age of participants (Source: Authors)



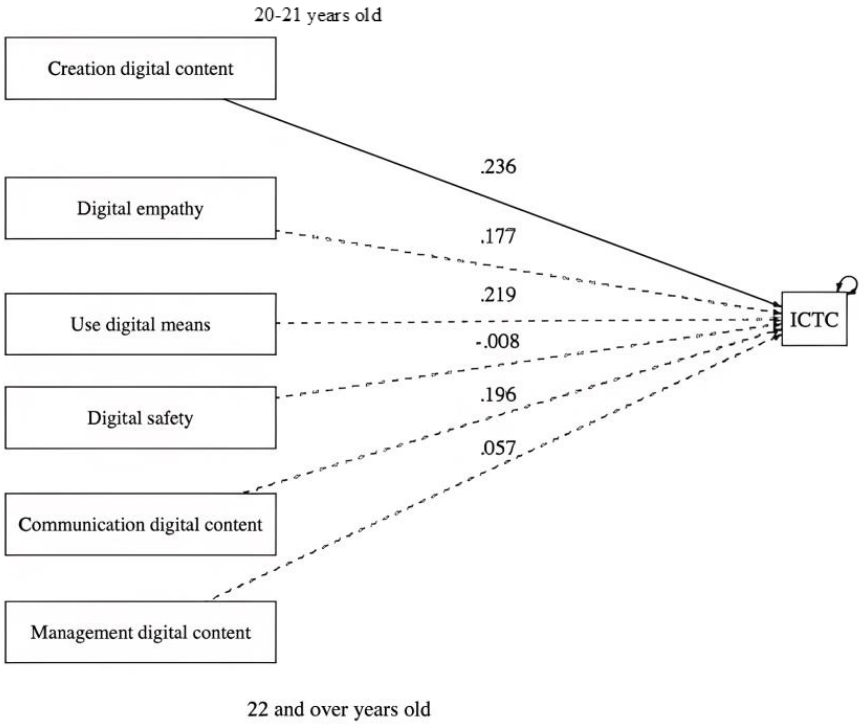




**Figure 6 (continued).** Path analysis result based on age of participants (Source: Authors)

Based on the path analysis, there are noteworthy differences between females and males in the impacts of various digital skills dimensions on ICTC (**Figure 7**). The management of the digital content dimension does not show a statistically significant relationship with ICTC in either gender. UDMs dimension has a significant positive relationship with ICTC in both genders. However, the impact appears to be stronger in females (estimate: 0.382, p-value: 0.000) than in males (estimate: 0.246, p-value: 0.023). CDC dimension does not have

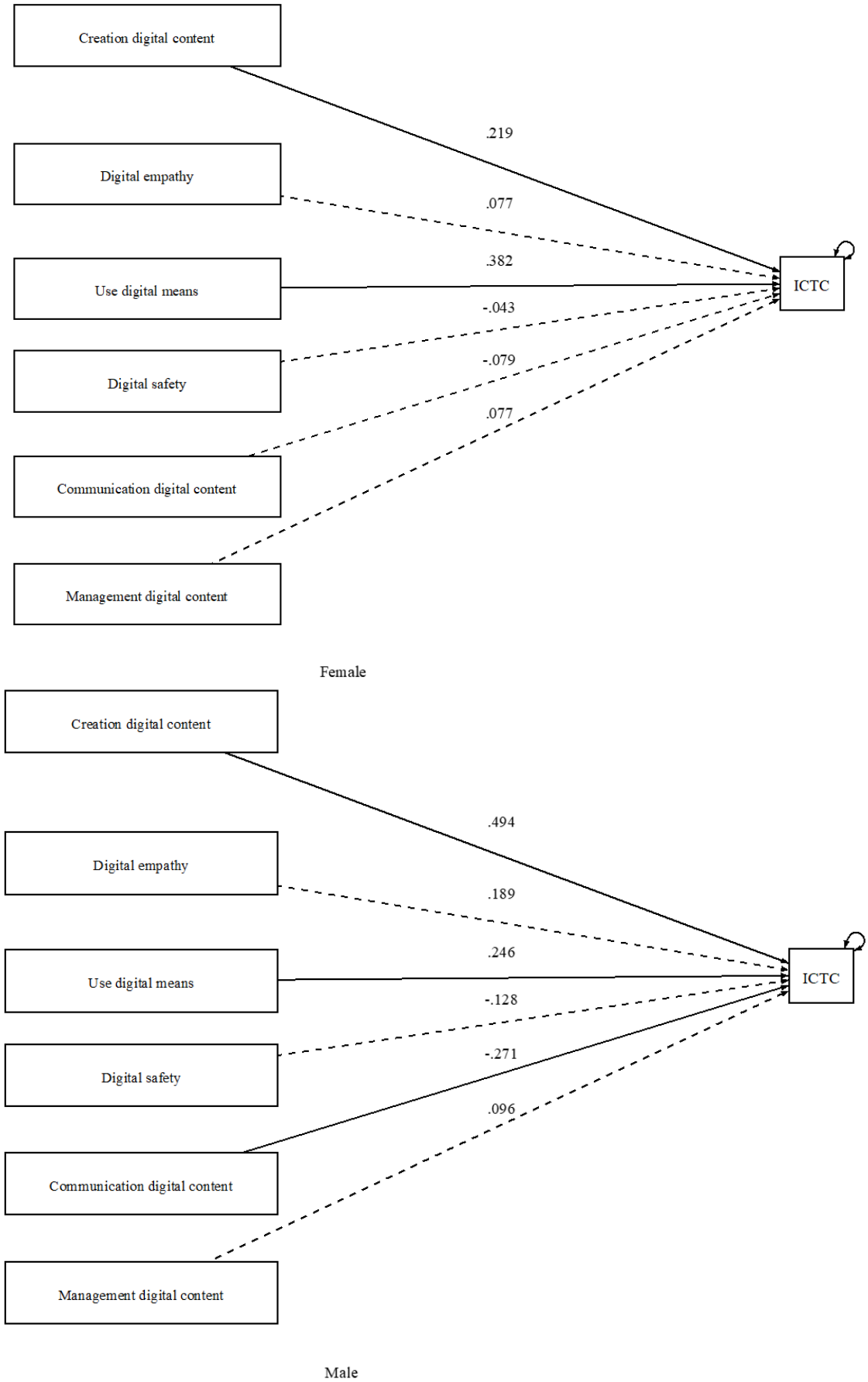



**Figure 7.** Path analysis result based on gender (Source: Authors)

a significant impact on ICTC in females. However, it exhibits a significant negative relationship with ICTC in males (estimate: -0.271, p-value: 0.01). DS dimension does not show a significant relationship with ICTC in either gender. The creation of digital content dimension demonstrates a significant positive relationship with ICTC in both genders, though the effect is more pronounced in males (estimate: 0.494, p-value: 0.000) compared to females (estimate: 0.219, p-value: 0.013). The digital empathy dimension does not show a significant relationship with ICTC in either gender, although the impact in males approaches the threshold for significance (estimate: 0.189, p-value: 0.063). Lastly, regarding the R-Square value, the dimensions collectively account for a greater proportion of the variance in ICTC in males (38.1%) compared to females (28.2%). These results suggest that the importance of different dimensions of ICTC can vary across genders, potentially due to different experiences and engagement with digital content and technology between males and females.

## DISCUSSION

The goal of this study is to explore correlation between ICTC and digital skills. It focuses on which of digital skills sub-dimensions has a greater impact on ICTC and how this impact varies by nation, age, and gender.

The findings of this study show that participants generally have a high level of abilities in digital skills and ICTC. In particular, "CDC" dimension received the highest average score, while the "creation of digital content" and "use of digital tools" dimensions also received high scores. This indicates that participants generally have good abilities in creating, managing, and communicating digital content effectively. In contrast, ICTC's average score is lower, indicating that participants have a more moderate level of ability in this area. This may suggest that participants may need further training or support in using and applying their digital skills effectively. In conclusion, these findings confirm that digital skills and ICTC are vital for individuals to be successful in the digital age.

In the study conducted in Latvia, the majority of university students think that digital skills and ICT competencies expected from them in their future profession should be developed (Zeidmane & Vintere, 2021). The survey with prospective teachers studying at an Irish University shows that while students actively use social media and technology platforms, their use is concentrated in a narrow spectrum of technology. This indicates that their exposure to various digital technologies is limited, possibly because they use the technology as needed (McGarr & McDonagh, 2021). In some studies, PSTs reported that their digital skills were high (Ata & Yildirim, 2019; Tomczyk et al., 2022) and moderate level (Pozas & Letzel, 2021).

Path analysis results show that the dimensions of "use of digital tools", "CDC" and "creation of digital content" significantly affect ICTC. However, "digital content management", "digital security" and "digital empathy" are not major influencers. Of these dimensions, "digital content creation" has the most significant impact in studies (Ally, 2019; Ata & Yildirim, 2019; Torres Kompen et al., 2019) argues that the ability to produce content is important for teachers and teacher candidates. There are notable country differences suggesting that social, economic or cultural factors may influence the acquisition and use of digital skills. For example, in Russia and Kazakhstan, "MDC" dimension has a significant positive impact only in Kazakhstan, while the "Use of digital tools" has a significant positive impact in both, with a stronger effect in Russia. "CDC" does not show a significant relationship in Russia but has a negative impact in Kazakhstan.

"Digital security" has a negative effect in Russia and a positive effect in Kazakhstan. The "creation of digital content" significantly affects Russia, but not Kazakhstan. No country shows a significant relationship for "digital empathy". The variance in ICTC is better explained in Kazakhstan (48.7%) than Russia (29.9%). This shows that the relationship between digital skills and ICT proficiency is affected by cultural structures and the education people receive. No studies have been found that directly examine the relationship between digital competence and ICTC. However, it is stated that Digital skills and ICTC can be affected by cultural structures and differ according to countries (Gutiérrez-Esteban et al., 2016; Shonfeld et al., 2021; Willems et al., 2019).

When examining the results by age groups, each age group shows different patterns of importance between the dimensions. "Digital content management" shows a significant relationship only in the 20-21 age group, and "digital tool use" only in the 18-19 age group. "Digital content communication" shows a negative relationship in the 18-19 and 20-21 age groups, and a positive relationship in the 22 and over age group. "DS" is not significantly associated with ICTC in any age group. "Digital content production" is gaining importance in the age groups of 18-19 and 22 and over. "Digital empathy" is not significant in any age group, but it

becomes significant in the age group 22 and over. ICTC variance is best explained in the group aged 22 and over (49.1%) compared to other groups. In the literature, there are studies (Gómez-Trigueros et al., 2019; Guillén-Gámez et al., 2019; Martzoukou et al., 2021; Mirķe et al., 2019; van Deursen & van Dijk, 2015) stating that digital skills and ICTC differentiate according to age group however according to the study conducted by Gibbs and Sagrista (2020), age is not affecting factor.

There are also gender differences in impact of digital skills on ICTC. There is a significant positive association with "use of digital tools" in both genders, but this effect is stronger in women. "CDC" has a negative effect only on men. "Digital content creation" is significantly positive for both genders, more pronounced in men. None of the other dimensions show a significant relationship. Variance in ICTC is better explained by males (38.1%) than females (28.2%). This shows that different dimensions of ICTC may vary between genders due to different experiences and participation in digital content. In the literature, there are studies stating that digital skills and ICTC differ according to gender (Yu & Hu, 2022), as well as studies stating that there is no differentiation (Gibbs & Sagrista, 2020; Guillén-Gámez et al., 2019; Pozas & Letzel, 2021).

## CONCLUSIONS

This study examined the relationship between digital skills and ICTC. The findings showed that the sub-dimensions of digital skills had a significant impact on ICTC. In particular, the dimensions of "use of digital tools", "CDC", and "creation of digital content" have a statistically significant effect on ICTC. On the other hand, "MDC", "digital security", and "digital empathy" dimensions do not have a significant effect on ICTC. In addition, this study examined how the impact of digital skills sub-dimensions on ICTC varies by country, age and gender. The findings showed that the impact of these dimensions can vary significantly between different demographic groups. For example, the impact of "MDC" dimension differs significantly between Russia and Kazakhstan, while the impact of the "use of digital tools" dimension varies significantly between different age groups. In addition, the impact of the "creation of digital content" dimension varies significantly by gender.

These findings suggest that digital skills and ICTC may develop differently among different demographic groups, and their interactions with digital content and technology may differ. This suggests that strategies for developing and promoting digital skills and ICTC need to be tailored to suit the needs and experiences of specific demographic groups. In conclusion, this study confirms that digital skills and ICTC are vital for individuals and societies to succeed in the digital age. It also shows that these skills and competencies may develop differently between different demographic groups and that these groups' interactions with digital content and technology may differ.

Education policies and programs should focus on development of digital skills and ICTC. In particular, special attention should be paid to "use of digital tools", "CDC", and "creation of digital content" dimensions as the dimensions have the greatest impact on ICTC. Educators and policy makers should consider how digital skills and ICTC vary between different demographic groups. For example, the impact of "MDC" dimension differs significantly between Russia and Kazakhstan, while the impact of the "use of digital tools" dimension varies significantly between different age groups. This suggests that strategies for developing and promoting digital skills and ICTC need to be tailored to suit needs and experiences of specific demographic groups. Strategies for development of digital skills and ICTC should also consider gender differences. For example, impact of "creating digital content" dimension varies significantly by gender. This suggests that strategies for developing and promoting digital skills and ICTC need to be adapted to consider gender differences.

This study focused on specific dimensions of digital skills and ICTC. However, other dimensions may also be important and should be considered in future studies. This study examined how digital skills and ICTC differ between different demographic groups. However, there may be other factors that influence how these groups interact with digital content and technology. These factors should be considered in future studies. This study used a specific scale to measure the impact of digital skills and ICTC.

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**Ethics declaration:** The authors declared that the study did not require any ethical approval. This research study has been conducted in accordance with ethical principles that prioritize the welfare, dignity, and rights of all participants.

The following measures were implemented to ensure ethical conduct throughout the study. All participants were informed about the nature of the study, including the aim, the methods used, and their role. They were clearly communicated that their participation is voluntary and that they have the right to withdraw from the study at any time, for any reason, without any negative consequences. Participants were instructed not to do anything that would reveal their identity during the study. The authors further declared that they committed to protecting the personal identity and data of all participants. Personal identifiers were not collected or linked with the participants' responses. All data collected during this research is used solely for the purpose of this study and will not be disclosed to any third parties. The participation in this study was purely voluntary. Participants were not subjected to any form of coercion and were free to withdraw from the study at any time they choose.

**Declaration of interest:** Authors declare no competing interest.

**Data availability:** Data generated or analyzed during this study are available from the authors on request.

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