Digital Competencies: Are Pre-Service Teachers Qualified for Digital Education?

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Article Info	Abstract
	This study examines digital competency (DigComp) as a crucial component of twenty-first century teachers. It investigates pre-service teachers' level of DigComp from their perspective, and whether they felt their preparation programme qualified them for digital education. One hundred forty student teachers in their final year of majoring in either art education or kindergarten at a public university in Saudi Arabia participated. Data was collected via an online survey that included five DigComp areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving. Significant differences were found between the two groups: the communication and collaboration domain had the highest mean in both groups (152.47 ± 19.39; 139.40 ± 17.79); while the safety domain had the lowest mean score in both groups (16.48 ± 2.62; 15.06 ± 3.35). Results showed that 77.1% of pre-service teachers rated their DigComp as excellent and 22.9% rated it as moderate. The results further revealed that the pre-service teacher programme was average (65.04%) in qualifying pre-service teachers to integrate technology into their future teaching practices. The results of this study highlight the necessity to evaluate pre-service teacher programmes for suitability to produce instructors who possess the cognitive, teaching, and digital competencies required in the era of technology.

Introduction

Digital technology has recently emerged as a promising, powerful, and transformative tool for achieving new educational objectives. There is a strong argument for using technology-based teaching and learning tools to replace traditional teaching practices (Drent & Meelissen, 2008; Fullan & Smith, 1999; Ghavifekr & Rosdy, 2015). Traditional educational settings, according to Office of Educational Technology (2017), do not meet the expectations of the new generation of students who seek to organise their own learning experiences. Consequently, incorporating information, communication, and technology (ICT) into education has become a fundamental requirement that should not be underestimated. However, several problems and difficulties for teachers, particularly those with digital illiteracy, may accompany this new trend (Daniels et al., 2020; Nicol et al., 2018).

According to research studies, the majority of teachers lack the necessary knowledge and skills to effectively integrate technology into the classroom (Krumsvik, 2011; Yang, 2020). Thus, training teachers on how to use technology in their classrooms in a way that is acceptable, effective, and intentional is critical (Puerling, 2012).

In light of this, education ministries around the world have set policies and provided extensive training and resources for teachers to improve the use of new technology in the curriculum, teaching, and learning process (Albirini, 2006; Ihmeideh, 2009). In UNESCO (2011), this went even further, emphasising the necessity of improving pre-service teacher's digital abilities to integrate technology into their lesson preparation and teaching. According to Camilleri and Camilleri (2017), European countries should provide a compulsory course in ICT for pre-service teachers as an essential competent in all initial teacher education programmes. This recommendation applies to all Arabic countries, including the Kingdom of Saudi Arabia (KSA). Digital competence is 'broadly defined as the confident, critical and creative use of ICT to achieve goals related to work, employability, learning, leisure, inclusion and/or participation in society' [Ferrari, 2013, p. 2].

In the KSA, an interest in digital education arose with several steps taken by the Ministry of Education (MOE) such as establishing the National Centre for e-Learning and Distance Learning in 2005; followed by the Saudi Digital Library in 2010 and Saudi Electronic University in 2011 (Aldiab et al., 2017). The MOE has further recently generated a new 'Developing Study Plans Guide', which indicated that one of the justifications for developing plans and curricula is promoting digital learning in education (Ministry of Education, 2021). These proceedings match Saudi Arabia's National Transformation Program 2020 and the Vision of 2030, which paid great attention to supplying the higher education sector with e-Learning (Aldiab et al., 2017). The COVID-19 pandemic has also turned the KSA education system into online learning (O'Keefe et al., 2020) as a quick and effective solution to continue the educational process. Many Saudi educators, as a result, found themselves fast migrating to remote learning without sufficient skills, knowledge, or resources (O'Keefe et al., 2020).

Saudi Arabia is further interested in research in the field of digital learning, particularly in higher education. For example, one research study attempted to determine the digital transformation competencies and skills required to enable Saudi universities to perform their digital roles efficiently (Alhazmi & Yamani, 2021). Others have discussed the necessity for an e-learning system of education and the type of limitations that could affect this system in the KSA (Aldossary, 2020). Evaluating and defining undergraduate students' digital competencies in information science specialties (Yamani et al., 2021), the English language (Hazaea & Alqhtani, 2020), and different study areas (Barri, 2020) were a subject of investigation. Examining undergraduate students' viewpoints of distance learning during and after the COVID-19 pandemic (Alsmadi et al., 2021; Ibrahim & Hidayat-ur-Rehman, 2021) is another subject of research studies. Moreover, there has been relatively little research conducted to understand the role of integrating technology into the Saudi pre-service teacher education curriculum from the standpoint of policymakers and the analysis of Saudi national and curriculum policies (Al-Zahrani, 2015).

Based on this, it seems that no study has yet investigated the digital competency (DigComp) of Saudi student teachers from their own perspective. There are few national studies regarding the extent to which teacher preparation programmes contribute to teacher qualification for digital education. The researcher's observations

during supervision on the field training course over the last five years supported the need for this research. Most female student teachers avoided technology in their teaching practice. Furthermore, during COVID-19, in which the student teachers were trained to teach remotely, there were differences in the level of technology use among the trainee student teachers. The current study was carried out to investigate how female student teachers at the College of Education (COE) in a Saudi public university perceived their digital competencies. To what extent does the pre-service teacher programme contribute to qualifying them for digital education from their point of view? Is there any difference between student teachers regarding their level of digital competencies for the five domains included in the study: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving? This study examined two concepts: pre-service teachers' digital competencies and the pre-service teacher programme.

Literature Review

Pre-Service Teachers' DigComp

Digital competencies represent vital tools that enable an individual to participate in all aspects of the society as an effective citizen (Ata & Yıldırım, 2019). It was further classified as one of the basic skills teachers must possess (Tomczyk, 2021). A growing body of literature has emphasised the value of developing student teachers' DigComp and the responsibility of initial teacher programmes toward this target (Ata & Yıldırım, 2019; Lindfors et al., 2021; Liu, 2012; Murley, 2013). Masoumi (2021) described enhancing pre-service teachers' DigComp in initial teacher institution as a process that would enable them to reflect, interact, and employ technological knowledge in their educational practice in the future. DigComp would further enable student teachers to maintain instructional self-efficacy in technology-rich classrooms (Elstad & Christophersen, 2017). According to Lankshear and Knobel (2005), digital competence usually includes the capability to use software and hardware. However, Janssen et al. (2013) reported that digital competence:

> … clearly involves more than knowing how to use devices and applications – which is intricately connected with skills to communicate using ICT as well as information management skills. Besides, sensible and healthy use of ICT requires particular knowledge and attitudes regarding legal and ethical aspects, and privacy and security, as well as an understanding of the role of ICT in society and a balanced attitude towards technology (p. 480).

Svensson and Baelo (2015) outlined teaching DigComp that result from a combination of technological skills and knowledge, awareness of the methodological capabilities offered by technological resources, and an individual's attitude toward the optimal use of ICT to develop and improve education. Teachers in the twenty-first century are required to have a high degree of DigComp and preparedness to use digital technology in the classroom, as one of the promising efforts to satisfy the needs of the digital-native generation, or millennials (Liza & Andriyanti, 2020). Previous research documented student teachers displaying various degrees of DigComp, including elementary (Tezci, 2011; Vukčević et al., 2021), moderate (Çebi & Reisoğlu, 2020; Tomczyk, 2021; Vukčević et al., 2021), high-level, and a pleasant experience with digital competences (Ata & Yıldırım, 2019; Batane & Ngwako, 2017; Liza & Andriyanti, 2020; Milutinović, 2019). The disparities here, however, could be due to factors other than academic preparation. Furthermore, whether a student teacher's DigComp level is high or

moderate will not guarantee that they will be able to use it effectively in their classroom. Gudmundsdottir and Hatlevik (2020) found that, during field training, student teachers were more concerned with the technical aspects of ICT than with responsible or pedagogical ICT use.

Pre-Service Teacher Programme

In 2011, the Saudi Arabian Higher Education Reform project (AFAQ) was launched, which represents a strategic plan for introducing e-learning and other new technologies into higher education to improve the quality and use of ICT among students and faculty members (Alzahrani, 2017). Logically, teacher preparation programmes are one of the platforms included in this project, as teachers are at the forefront of education reform. Hence, they must participate in the integration of ICT in education (Wachira & Keengwe, 2011).

Furthermore, the criteria that define qualified teachers have completely changed; they are no longer limited to a teacher's content-specific and pedagogical knowledge. Rather, they went beyond that to technological know-how (Alhawiti, 2013). This claim is consistent with Mishra and Koehler (2006) assertion that teachers must grasp more than the subject area they teach; they must also have a deep understanding of how the subject matter '(or the kinds of representations that can be constructed)'(p.7) can be changed by the application of technology. Al Khateeb (2017) stated that most Saudi teachers are not adequately digitally competent, as they do not match the standards of good digital teachers required for the twenty-first century. Similarly, Al Mulhim (2014) concluded there is clear evidence that Saudi pre-service teachers are not adequately qualified for the Information Age. Accordingly, Alzahrani (2017), a Saudi scholar, suggested that training on ICT and how to use it represent a crucial demand that Saudi universities must provide to their students; in particular, pre-service teachers.

Nowadays, almost all teacher preparation programmes worldwide have training in technology (Yüksel & Kavanoz, 2011). They at least provide one compulsory course in computer competency for undergraduate students. This approach would put new teachers in a better position than their predecessors. First, they would not have to change their teaching habits that they had built over a long period (Batane & Ngwako, 2017). Second, they would not have to face the difficulties and challenges that their predecessor's faced when they switched to digital education. Third, they would successfully create a rich learning environment and direct Generation Z to the effective use of technology (Fullan & Smith, 1999; Gibson, 2001).

Technology improves students' achievement (Jamieson-Proctor, et al., 2013; Kaur, 2020), assists them to access information, collaborate with others, communicate information, think creatively, express themselves, and construct knowledge (Fullan & Smith, 1999; Gibson, 2001; Nath, 2019). The literature review suggested that pre-service teachers may receive knowledge and skills of ICT; however, they seem unqualified to implement them in a classroom setting (Liu, 2012; Maddux & Cummings, 2004). Kay (2006) reported that pre-service teachers are not allowed to build their own technology-based lessons. Pre-service teacher programmes, as well as the teacher educators concerned with them, have a great responsibility in creating the appropriate educational environments to develop a high level of DigComp for new teachers (Lund et al., 2014).

Theoretical Framework

Digital competence is a complex concept that is not limited to the operation of hardware and software only (Tomczyk, 2021). Several international institutions attempted to establish a conceptual framework around this terminology (Çebi & Reisoğlu, 2020; Garzón-Artacho et al., 2021). One outstanding framework was the European Digital Competence Framework for Citizene, also known as the DigComp framework (Garzón-Artacho et al., 2021; Stephanie et al., 2017). This DigComp framework is an instrument for improving citizens' digital proficiency, assisting policymakers in formulating policies that support DigComp building, and planning education and training initiatives aimed at specific target groups. The DigComp framework further provides a consistent vocabulary for identifying and describing essential areas of DigComp, making it a helpful resource (Stephanie et al., 2017) for individuals interested in this field. The framework covers five competence areas: information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Stephanie et al., 2017), considering that each area has sub-competencies.

In this study, DigComp framework is adopted as a theoretical framework for its comprehensiveness. It further provides examples of how to employ the DigComp framework (Stephanie et al., 2017), remaining mindful of the role teachers play in building and developing DigComp. Furthermore, this study predicts that this research will promote the necessity to develop DigComp for future teachers.

Materials and Methods

Study Context

The investigation was carried out in the COE, at a public Saudi university. Because the college is gender-segregated, the study was conducted in female departments at the undergraduate level, both for cultural reasons and ease of access by the researcher to the sample, being a staff member in the college (Cohen et al., 2002). Art education, kindergarten, and Education technologies are the three main topic areas of the female departments. The Education technologies major was not involved, as its graduates are familiar with technology. The study was conducted in the second semester of the academic year 2020/2021.

Design of the Study, Sample, and Sampling

A survey methodology was used for this research; data was gathered and analysed quantitatively. According to Cohen et al (2002), a survey approach is appropriate when the researcher intends to describe the nature of existing conditions, identify standards against which existing conditions can be compared, or determine the relationships that exist between specific events. It provides inferential, descriptive, and explanatory information. A survey also allows for easy distribution to large groups, is anonymous, and can provide massive data and a broad overview of a subject field (Johnson & Onwuegbuzie, 2004).

The study targeted all (207) student teachers at the COE in the university who enrolled in the field experience

course from both majors involved in the study. One hundred forty (68%) undergraduate students participated, with 75.7% being kindergarten education students and 24.3% being art education students. The purposive sampling technique was utilised. All participants were in their final year, and they had practised teaching for one semester in schools as a prerequisite for the field training course. They were reached by communicating with their field training supervisors and their classmates in the course.

Study Instrument: Development and Administration

A systematic questionnaire was used to assess the students' DigComp, and whether the COE pre-service teacher programme equips them to apply technology effectively in a real or virtual classroom. The latest version of the DigComp framework was used to develop the questionnaire (Stephanie et al., 2017), in addition to other studies' scales (e.g. Çebi & Reisoğlu, 2020; Chen & Chang, 2006; Gudmundsdottir & Hatlevik, 2020). Moreover, the researcher produced some additional items and questions to prompt the responses needed to answer the research questions.

The questionnaire comprised closed-ended questions and one open-ended question. It used the five-point Likert scale: strongly agree (5), agree (4), partially agree (3), disagree (2), and strongly disagree (1); it was expected to take 8-10 minutes to complete. The questionnaire screened three sections; the first section covered the participant's demographic information, such as department (art education, kindergarten) and overall rating (excellent, moderate, weak). The second section focused on DigComp. It included questions about how student teachers rate their overall degree of DigComp, in addition to their level of proficiency in the study's five DigComp elements; namely, information and data literacy (five items; $\alpha=0.808$), communication and collaboration (14 items; $\alpha=0.917$), digital content creation (seven items; $\alpha=0.879$), safety (four items; $\alpha=0.871$), and problem solving (seven items; $\alpha=0.883$).

The third section focused on the COE's pre-service teacher programme at the university. It comprised five closed questions/items, which requires answering according to the five-point Likert scale as mentioned above, as follows:
- How many accredited courses have you taken at the programme, related to educational technology and its use in the classroom?
- The teacher education programme at my university has provided me with a strong foundation for integrating technology into my teaching
- The educational courses in the programme, such as lesson design, special teaching methods, and others, deal with subjects related to the use of technology in teaching
- There is a need to integrate technology into the educational courses in the programme (e.g. special teaching methods, lesson design)
- There is a need to make changes in teacher preparation programmes in the COE so that educational technology is employed in an integrated manner in teaching and learning.

The section also had one open-ended question associated with adding any comments related to the strength of DigComp that the participant believed would contribute to the development of teacher preparation programmes.

Also, other miscellaneous questions/items were included in this section, such as 'Do you (student) have a positive attitude toward technology?' and I self-developed my DigComp.

Two experts of educational technology assessed the questionnaire to ensure its validity. Following their feedback, it was modified and restructured. The researcher received ethical approval from King Faisal University's Research Ethics Committee (REC REF Number: KFU-REC/2021-06-41) to conduct this study. The questionnaire was then converted to an electronic format and distributed by WhatsApp message to the student teachers' supervisors in the field training course, who subsequently passed it on to their trainees. The questionnaire link was also shared on the COE's Telegram account to ensure a sufficient number of responses.

Data Analysis

All data was analysed using Statistical Package for the Social Sciences, version 23, to answer the research questions. The study variables' frequencies, percentages, means, and standard deviations were calculated using descriptive statistics. A Pearson correlation was used to establish the relationship between the questionnaire items, and the results showed that there is a strong correlation between the research variables, with r values starting from 0.576 to 0.770 (see Table 1).

Table 1. Correlations among DigComp Dimensions

No	Pearson correlation	1	2	3	4	5
1	Information and data literacy	1				
2	Communication and collaboration	0.725**	1			
3	Digital content creation	0.578**	0.719**	1		
4	Safety	0.576**	0.621**	0.634**	1	
5	Problem solving	0.576**	0.770**	0.719**	0.707**	1

**p<0.001

To find if there was a difference between the research variables, Chi-square tests were used. The researcher also ran an independent sample test to examine if there were any variations between the study variables. The level of statistical significance *(*p<0.05)* was acceptable for all tests. Data that emerged from the survey's open-ended question was used to discuss and interpret the results.

Results

The results in Table 2 below show that the majority of the students polled consider they have a high degree of DigComp; 77.1% of the participants reported they possess an excellent level of DigComp, while 22.9% estimated their level of DigComp as moderate. Data analysis revealed that pre-service teacher programmes were seen as fairly average in terms of preparing graduates to integrate technology into the classroom, as the responses of the participants were 7.2% 'strongly agree', 25.7% 'agree', 32.14% 'partially agree', 24.3% 'disagree', and 10.7% 'strongly disagree'.

Table 2. Participants' Perspectives regarding their Level of DigComp and the Contributions of their Pre-service Programme to their DigComp

Variables	All (140)	Excellent 108 (77.1%)	Moderate 32 (22.9%)	p
Overall rating				
Excellent	49 (35.0%)	38 (35.2%)	11 (34.4%)	0.594
Moderate	83 (59.3%)	65 (60.2%)	18 (56.3%)	
Weak	8 (5.7%)	5 (4.6%)	3 (9.4%)	
Number of technology courses				
One course	14 (10.0%)	9 (8.3%)	5 (15.6%)	0.319
Two courses	60 (42.9%)	45 (41.7%)	15 (46.9%)	
Three courses	66 (47.1%)	54 (50%)	12 (37.5%)	
Pre-service teacher education qualified me to integrate technology into my teaching				
Strongly disagree	15 (10. 7%)	11 (10%)	4 (12.5%)	0.042*
Disagree	35 (24.3%)	26 (24%)	9 (28.2%)	
Partially agree	45 (32.14%)	35 (32%)	10 (31.2%)	
Agree	36 (25.7%)	29 (27%)	7 (21.8%)	
Strongly agree	9 (7.2%)	7 (7%)	2 (6.3%)	
Existence of technology in the content of educational courses				
Strongly disagree	3 (2.1%)	1 (0.9%)	2 (6.3%)	0.372
Disagree	17 (12.1%)	13 (12.0%)	4 (12.5%)	
Partially agree	49 (35.0%)	40 (37.0%)	9 (28.1%)	
Agree	54 (38.6%)	42 (38.9%)	12 (37.5%)	
Strongly agree	17 (12.1%)	12 (11.1%)	5 (15.6%)	
Essential inclusion of technology in the content of educational courses				
Strongly agree	0	0	0	0.395
Disagree	0	0	0	
Partially agree	29 (20.7%)	21 (19.4%)	8 (25.0%)	
Agree	62 (44.3%)	46 (42.6%)	16 (50.0%)	
Strongly agree	49 (35.0%)	41 (38.0%)	8 (25.0%)	
Need to make a change in pre-service teacher programme				
Strongly disagree	0	0	0	0.179
disagree	2 (1.4%)	2 (1.9%)	0	
Partially agree	30 (21.4%)	19 (17.6%)	11 (34.4%)	
Agree	55 (39.3%)	43 (39.8%)	12 (37.5%)	
Strongly agree	5 3(37.9%)	44 (40.7%)	9 (28.1%)	

Variables	All (140)	Excellent 108 (77.1%)	Moderate 32 (22.9%)	p
Self-developed digital competencies				
Strongly disagree	0	0	0	0.001*
Disagree	4 (2.9%)	0	4 (12.5%)	
Partially agree	19 (13.6%)	13 (12.0%)	6 (18.8%)	
Agree	49 (35.0%)	40 (37.0%)	9 (28.1%)	
Strongly agree	68 (48.6%)	55 (50.9%)	13 (40.6%)	
Students' positive attitude toward technology				
Strongly disagree	0	0	0	0.001*
disagree	4 (2.9%)	0	4 (12.5%)	
Partially agree	29 (20.7%)	20 (18.5%)	9 (28.1%)	
Agree	53 (37.9%)	44 (40.7%)	9 (28.1%)	
Strongly agree	54 (38.6%)	44 (40.7%)	10 (31.3%)	

*p>0.05

The survey also sought to determine how much technology is present in the content of educational courses in the COE programme. The majority of respondents were in agreement: 38.6% responded 'agree' and 35.0% 'partially agree'. Furthermore, the percentages of 'strongly agree' and 'disagree' were equal at 12.1%. With respect to the need to incorporate technology into the programme curriculum materials, all student teachers agreed on this suggestion, with 44.3% saying 'agree', 35.0% stating 'strongly agree', and 20.7% citing 'partially agree'. Results also revealed that the majority of participants agreed on the need for a reform in pre-service teacher programmes, with 39.3% agreeing, 37.9% strongly agreeing, and 21.4% partially agreeing.

The available evidence showed that the majority of student teachers agreed that they built their own DigComp, with the highest percentages of 'strongly agree' (48.6%), 'agree' (35.0%) responses, and partially agree (13.6%). It further detected student teachers' positive attitudes towards technology, as indicated by their responses: 38.6% 'strongly agree', 37.9% 'agree', and 20.7% 'partially agree'. Interestingly, students' responses to the number of technology courses were varied, with 47.1% reporting three courses, 42.9% reporting two courses, and 10% reporting only one course.

When examined whether there were any differences between student teachers' levels of DigComp across the five competency areas studied (information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving), a significant difference was found in favour of those with high DigComp, with a mean score of 152.47±19.39, compared to those who rated their level of DigComp as moderate (139.40± 17.79). In the area of communication and collaboration (e.g. selecting adequate digital technologies to interact with others, using common social media applications in group work) student teachers' initial mean score was the highest compared to the mean scores of the other four dimensions (58.27±7.55). This was followed by digital content creation (e.g. applying various ways to create and edit content in different formats, manipulating and modifying different elements of digital content to create new and innovative elements) where it recorded a mean

score of 28.07±4.59. Problem solving appeared to be at the third rank (e.g. determining the type of support that would solve a technical problem, identifying potential technical problems when operating devices using digital environments) with a mean score of 27.30±4.52. Information and data literacy was next (e.g., determining the appropriate sources of information [websites, blogs, digital books]to obtain data to perform the required tasks, organising and conducting specific search strategies to find data, information, and content in digital environments) with a mean score of 19.68±3.18. The lowest mean score was related to safety (16.15±2.86) (e.g. applying different ways to protect devices and digital content, distinguishing risks in digital environments) (see Table 3).

Table 3. Mean and Standard Deviation Scores of the Five DigComp Areas

Digital competencies (mean+ SD)	All (140)	Excellent 108 (77.1%)	Moderate 32 (22.9%)	p
Information and data literacy	19.68±3.18	20.12±3.17	18.18±2.76	0.002*
Communication and collaboration	58.27±7.55	59.33±7.24	54.68±7.60	0.002*
Digital content creation	28.07±4.59	28.63±4.77	26.15±3.34	0.007*
Safety	16.15±2.86	16.48±2.62	15.06±3.35	0.013*
Problem solving	27.30±4.52	27.88±4.41	25.31±4.40	0.004*
Total	149.48±19.75	152.47±19.39	139.40± 17.79	0.001*

*$p>0.5$

Discussion

Globally, the necessity for developing the DigComp of pre-service teachers, and the role of teacher preparation programmes in achieving this target, has been recognised (Ata & Yıldırım, 2019; Lindfors et al., 2021, Masoumi, 2021; Štemberger & Konrad, 2021). Research showed that pre/in-service teachers are unprepared for digital education (Al Khateeb, 2017; Al Mulhim, 2014). The main purpose of this study was to investigate whether pre-service teacher programmes at the COE enable its graduates to use digital technology in their future teaching, and to evaluate student teachers' DigComp from their point view.

In general, the majority of student teachers perceived their level of DigComp as excellent. These conclusions are supported by published study findings, indicating the high level of DigComp of pre-service teachers (Ata & Yıldırım, 2019; Batane & Ngwako, 2017; Eryansyah et al., 2020; Liza & Andriyanti, 2020; Milutinović, 2019). However, participants' self-reported DigComp may not be an accurate reflection of their actual ability to use technology effectively in their teaching practices (Gudmundsdottir & Hatlevik, 2020) or its continued use in teaching (Štemberger & Konrad, 2021). The available data showed that student teachers who rated their DigComp level as excellent had a higher statistically significant mean than those who rated their DigComp level as moderate in the five DigComp areas studied namely.

Based on data analysis, the responses of pre-service teachers towards DigComp in the domain of communication and collaboration was the highest compared to the rest of the DigComp areas under investigation. This is consistent with the findings of Štemberger and Konrad (2021), who found that student teachers use

communication tools and digital resources on a basic level more than the other DigComp areas studied. Similarly, the communication and collaboration area was at the second highest level of DigComp, according to Çebi and Reisoğlu (2020). This could be attributed to the ease and widespread use of social networks for business, leisure, and social interactions (Ata & Yıldırım, 2019; Esteve-Mon et al., 2020). Regarding the lowest DigComp area from the participants' perspective, the results of this study were in parallel with the findings of Çebi and Reisoğlu (2020) and Porln and Snchez (2016). It also revealed that safety was the lowest DigComp. This could be explained by the fact that the course titled 'Introduction to the Computer', which is taught at the COE, provides students with knowledge and training on certain fundamental apps (e.g. Word, PowerPoint, Excel, email). However, it seems that there was no training on how to 'protect their privacy and online reputation, as well as their confidence in their ability to use the internet to protect themselves against online bullying, spam, and junk mail' [Wastiau et al., 2013 , p.18]. Currently, the university runs annual workshops for students on how to use technology effectively and deal with the digital world.

Results further showed that student teachers assessed pre-service teacher programmes at the COE as fairly average in equipping them for integrating technology in teaching, whether for field training or their future teaching career. In this context, previous literature concluded that pre-service teachers have not been effectively trained to integrate ICT into their future instructional practices in school (Masoumi, 2021). Similarly, Liu (2012) stated that most pre-service preparation programmes worldwide do not educate graduates to use technology in instructional contexts despite technology being a required course in these programmes. This conclusion raises the following question: are there any factors other than academic preparation contributing to students' excellent DigComp level? On one hand, previous literature suggests that student attitude has a significant impact on the acceptance or rejection of new technology learning, adoption, and integration (Chien et al., 2018; Elstad & Christophersen, 2017; Tezci, 2011). In the current study, student teachers from both levels (excellent/moderate) showed a positive attitude towards technology, in which $p > 0.001$. This is consistent with the findings of Ata and Yıldırım (2019), who found that pre-service teachers had good attitudes about DigComp. As a result, student teachers may be self-motivated to improve their digital proficiency on their own. About 97.2% of respondents in this study claimed they acquired DigComp skills by themselves (Hartman et al., 2019). Thus, the results of this study support the relationship between student teachers' positive attitudes toward technology and their willingness to acquire knowledge and skills in this area.

On the other hand, how technology is taught or presented to student teachers during their college studies is expected to have a significant impact on their digital abilities. In the COE, where the study conducted, technology is taught as a compulsory discipline in 'Introduction to the Computer'. However, it is taught as an isolated discipline (Huang, 2018; Liu, 2012) in the first academic year. As a result, a student teacher is unlikely to receive comprehensive concepts and meaningful practice in merging technology in instruction (Huang, 2018; Liu, 2012). This assertion is consistent with Maddux and Cummings' (2004) findings that pre-service teachers are provided generic information and technical skills but not the capacity to integrate and use them in the classroom. Nevertheless, it is possible that student teachers studied some courses where their teacher educators relied significantly on technology to impart topic knowledge (e.g. PowerPoint, videos), or as a learning aid or as assessment method of student performance (Aslam et al., 2020). According to Wastiau et al. (2013) and Bracewell

and Laferriere (1996), there is a correlation between the advantages that students gain from using new technologies and teachers' technological skills and attitude towards technology and its presence in their teaching. This guides us to the necessity of teacher educators as role models for digital teaching to their students, which, in turn, would help student teachers to successfully integrate ICT into their future career (Çebi & Reisoğlu, 2020; Tezci, 2011; Wastiau et al., 2013).

Analysis of the data also revealed somewhat contradictory responses, in which the participants first emphasised the presence of technology in the context of educational curricula, as follows: 12.1% strongly agree, 38.6% agree, and 35% disagree. They then all underlined the importance of incorporating technology into educational curriculum. This argument was also made in several responses to the survey's open-ended question, in which some student teachers proposed the necessity for workshops, programmes, or specific courses in digital learning, as well as practising teaching by employing digital learning. The content of the educational courses given in both fields, kindergarten and art education, concentrate more on how to design teaching and how to teach face-to-face in classrooms. This may explain the conclusion drawn by Liu (2012), that it is essential to re-examine professional courses at pre-service teacher programmes to ensure their competence and to consolidate student teacher use of technology while practising teaching. This suggestion could also encompass all aspects of pre-service teacher programmes (e.g. vision, goals, outcomes, curricula, faculty members, teaching strategies, assessment methods, college environment, support) to ensure their eligibility in terms of preparing the teachers required in the twenty-first century.

Almost all of the participants in this study thought that a reform in pre-service teacher programmes is necessary. This conclusion has significant implications for pre-service teacher education programmes; it highlights the need to make great efforts towards developing DigComp graduates, and to ensure the integration of ICT in learning and teaching processes. Technology integration classes should be designed in such a way that pre-service teachers can see how effective and beneficial technology integration is in the classroom (Tezci, 2011). It might be true that student teachers have a high level of DigComp. However, they might employ new technologies more informally and less for educational reasons; and thus, they do not autonomously transfer their usage of new technologies to teaching and learning settings (Kumar & Vigil, 2011).

Limitations, Strengths, and Future Research

The current study includes some limitations that should be considered in future research. The first limitation is that the study was conducted in the COE at a Saudi public university, therefore the findings cannot be generalised to other Saudi teacher institutes. To address this limitation, the researcher recommends that the study be reproduced with a comparison to other Saudi or Arabic pre-service teacher institutes to support the value obtained from this study. Second, participants' actual level of DigComp was not assessed; this could affect the sincerity of data they provided (Koch et al., 2012). To overcome this limitation, an empirical study in which the researcher offers a realistic model or tools of how to incorporate digital education into pre-service teaching programmes is suggested; the results of Tian and Park's (2022) study concluded that neither universities nor societies can develop students' digital literacy in a traditional manner. Third, no explanation or causes were given by the participants

that could enable the researcher to understand why they considered their pre-service teacher programme as fairly moderate in qualifying them for digital education. Thus, a follow-up, mixed method study is recommended. Fourth, there was no focus on specialty as a variable in this study, and there are differences evident regarding this issue. According to Dedebali (2020), there was no significant difference between the DigComp scores of teacher students and the departments in which they were studying. In contrast, other research evidence revealed a substantial variance in participants' perceptions of digital literacy based on their specialties (Ata & Yıldırım, 2019; Koch et al., 2012). To take this issue into account, the researcher suggests completing a comparative study between the various branches in the COE.

Although this study has some limitations, it also has strengths. First, it discussed a vital topic and requirement in twenty-first-century education. Therefore, the response rate was high; about 70% of the target sample participated in the study. Second, an online survey was used as a tool to gather student teachers' perceptions, which gave them the freedom to answer without pressure or interference from the researcher. Third, based on the responses of the participants, the study revealed the need to develop pre-service teacher preparation programmes in line with the currently spreading digital learning revolution. Fourth, the study matches up with Vision 2030 and the digital transformations in education in the KSA. It sheds light on the importance of preparing qualified teachers for digital education, who can guide their students to benefit from the electronic platforms provided by the state, such as the Ain platform.

Conclusion

The educational environment has undergone tremendous transition in recent years as a result of the growth of information and communication technologies. Hence, pre- and in-service teachers are required to master DigComp to incorporate into their professional practice (Aslam et al., 2020; Garzón-Artacho et al., 2021) to achieve quality education in the twenty-first century (Štemberger & Konrad, 2021). This study focused on how female student teachers at a public university's COE assessed their DigComp; and, from their perspective, how effective the teacher preparation programme was in preparing them for digital education.

The findings revealed that the majority considered themselves as having excellent DigComp, although they stated that their preparation programme is fairly average in preparing them for digital education. It appears that other factors, such as student teachers' attitudes and teacher educators' as role models of technology in their lecture rooms, have a remarkable impact on student teachers' DigComp. Based on this, it can be concluded that pre/in-service teachers must possess a high level of DigComp, emphasising the importance of teacher education institutions in meeting this crucial requirement (Garzón-Artacho et al., 2021; Štemberger & Konrad, 2021).

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