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Competence in Digital Interaction and Communication—A Study of First-Year Preservice Teachers' Competence in Digital Interaction and Communication at the Start of Their Teacher Education

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ABSTRACT

This article explores the variation in first-year preservice teachers' professional competence in digital sharing and communication tools (software) by applying social constructivist learning theory and relevant concepts. The data were obtained from questionnaires distributed to 395 preservice teachers at two Norwegian universities in the first semester of 2019. Correlation and multiple regression are used for the analysis. The results reveal that the students' attitudes toward and experiences with virtual communication solutions were the main factors contributing to their competence in digital interaction and communication. The students' mastery of and emotional engagement with virtual collaboration solutions also played a definite but smaller role in their digital competence.

Introduction

The purpose of this article is to examine first-year preservice teachers' competence in digital interaction and communication. The background for the study is the increased demand, both in Norway and beyond, to improve teacher education in professional digital competences. Internationally, the European Framework for the Digital Competence of Educators (DigCompEdu) has identified six competences that should be prioritized in teacher education. One of these is competence in using, creating, and sharing digital learning resources in an efficient and responsible manner (Redecker & Punie, 2017, p. 9). Similarly, based on national and international research and policy documents (Arstorp, 2019), the Norwegian Directorate for Education and Training (Utdanningsdirektoratet) has formulated seven integrated competence areas to be implemented at all levels of education. One of the seven competence areas is digital interaction and communication (Utdanningsdirektoratet, 2018), which contributes to an

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improved sharing culture among preservice teachers. By digital sharing and communication in teacher education, we refer to the use of software, such as Microsoft Teams, Zoom, Skype, and, in particular, software developed for educational purposes (discussed below).

The ability to share resources and communicate digitally may also help students learn from one another. Sharing knowledge and learning about digital tools that help promote collaboration among preservice teachers may also foster a culture of sharing and communication that preservice teachers can bring to their future teacher practice. Thus, facilitating preservice teachers' interaction and collaborative learning may enable them to "work together to maximize their own or each other's learning" (Goodyear et al., 2014, as cited in Røkenes, 2016, p. 53).[1]

Despite the clear need to develop digital competence among teachers, research has shown that, both nationally and internationally, the requirements set in teacher education programs are not reflected in the digital competence that newly qualified teachers possess when they start teaching in schools (Instefjord, 2018; Instefjord & Munthe, 2017; Langset et al., 2018; Mikkelsen & Rist, 2018; Røkenes & Krumsvik, 2016). Although our data were collected before COVID-19, the pandemic has forced educators at all levels to conduct classes online, which has increased the need for students and teachers to be familiar with digital technologies. One of the main purposes of this study is to map the existing competences and skills of new students in teacher education in order to facilitate students' development and learning and ensure that teacher education meets the requirements for digital competence in interaction and communication. It also examines the factors that contribute to students' level of digital competence before they start their teacher education.

To this end, this study addresses the following research question: *What factors can explain the variation in preservice teachers' digital interaction and communication skills?*

In response to this question, we reviewed the literature and identified potential variables that might be relevant for a survey to be conducted among first-year preservice teachers. Drawing on previous studies (see below), we developed new items and tested the scales for measuring these potentially relevant variables. Having developed the questionnaire, we conducted a survey of 388 first-year preservice teachers attending teacher education programs on three campuses at two Norwegian universities. We performed a regression analysis based on the dependent variable *digital competence in interaction and communication* and the independent variables *positive attitudes toward digital interaction and communication tools* (hereafter abbreviated as *attitudes*), *emotional engagement*, *previous experiences*, *mastery expectations*, *age*, and *gender*.

The Norwegian context

Teacher education in the universities are all part of the same national plan and the detailed framework for their educational programs and courses (see Universities Norway, 2020). Despite a common national framework there might be differences in teaching between the two universities in the study. However, the main difference

[1]All Norwegian quotations in the article have been translated into English by the authors.

between university one and two are a split of students in two campuses and more digital teaching to students in particularly remote areas at university one.

University one offers teacher education for grades 1–10 on both campuses in Alta and Tromsø. These education programs are divided into grades 1–7 and 5–10. In the 2019–2020 academic year, which is when our study was conducted, this university had 550 active preservice teachers of which 136 were first-year students. At this university, a digital learning platform functions as a communication channel and academic resource bank between students and the educational institution. Teacher education is based on the principle of active student learning and principles that are more in line with flipped classroom model (Study catalogue, UiT). Flipped classroom can according to Gotaas (2016, p. 191) be described as what normally used to take place in the classroom, now takes place in arenas outside school, and the opposite way around. One can for example make a video for the students to watch at home and then use the time at school to process and discuss the content. The use of the flipped classroom model means that students must take responsibility for their own learning to a much greater extent than was previously the case. This promotes a more active way of learning. In this model, the role of the teacher also changes because there are fewer physical meetings between the teachers and their students. This means that well-designed didactic digital tools are needed to enable students to easily collaborate, interact, share, and communicate digitally with one another about their academic work.

The other university offers four teacher education programs. Two of these programs are aimed at primary and lower secondary school teachers, with five classes teaching grades 1–7 to around 175 students, and five classes teaching grades 5–10 to around the same number of students. All teaching related to specific subjects and didactics is provided by one educational department on one campus. There are also four classes with a total of 120 students in the lecturer education program, which covers teaching grades 8–13 (i.e., lower secondary school and upper secondary school). The programs, which address languages, sciences, and social studies, are anchored in the respective scientific departments, but the teaching is pedagogically oriented, and the subjects are spread over four years in the education department. In total, there were around 470 first-year preservice teachers at this university in the 2019–2020 academic year, and the sample of preservice teachers discussed in this article was drawn at random from that population. Communication with students in all programs takes place via a digital learning platform. Since all teaching takes place on campus, other digital learning tools are used to a lesser extent (fall 2019 before the pandemic).

Previous research

Several studies examining preservice teachers' digital competence have been conducted in Norway and internationally. Røkenes and Krumsvik (2016, p. 2) refer to previous international research showing little integration of interaction and communication technologies (ICT) and limited development of digital competence in teacher education. Newly qualified teachers reported feeling unprepared to use ICT in practice after completing their education. These findings are supported by those of Gudmundsdottir et al. (2014), who report that, following graduation, newly qualified teachers find little

connection between their education and the requirements they face with respect to using digital tools in schools. In a more recent study of professional digital competence among newly qualified teachers in Norway, teachers reported that the ICT training in their education was of poor quality (Gudmundsdottir & Hatlevik, 2018). Instefjord and Munthe (2017) report similar findings from a national Norwegian survey examining how professionally oriented digital competence was integrated into introductory subjects in teacher education. The preservice teachers viewed their own digital competence positively but were critical of how digital competence was taught in teacher education and of teacher educators' competence in using technology. Furthermore, a study by Aagaard et al. (2018) suggests that academic staff lack the competence and support to be able to provide education that can promote digitalization. Krumsvik and Jones (2017) found a "gap between the formulation and realization arena with regard to digital forms of learning in higher education" (p. 1). To compensate for the lack of connection between study plans in educational institutions and what is taught in practice, Krumsvik and Jones call for a focus on what they call digital leadership and the management of digital learning.

Furthermore, Instefjord and Munthe (2017) claim that the increased demand for digital competence among teachers requires new approaches to the integration of technology into education. Svensson and Baelo (2015) address this issue in their study of how preservice teachers perceive their own digital competence with a view to using it when they enter the profession in the future. Røkenes and Krumsvik (2016) identify a number of important factors for developing preservice teachers' digital competence: well-supported practical experience with ICT; solid didactic and pedagogical reasons for the use of ICT; access to digital resources and support functions; critical approaches to the use of digital aids; new forms of assessment and collaboration; and having teachers who are good role models. In contrast, Instefjord and Munthe (2017) find a weak positive correlation between a positive attitude toward management, management's support for development, and the digital competence of teacher educators. Their study also showed a stronger positive correlation between teacher educators' self-reported mastery beliefs and digital competence. In a recent study, Gourvennec and Nielsen (2019) examined how teachers used digital tools in practice and how this influenced their identities as teachers. Their findings indicate that knowledge of and access to digital technology opens up a wide variety of opportunities and resources for individual teachers.

Previous studies have also focused on preservice teachers' digital communication. Brodahl et al. (2011) conducted a survey of preservice teachers' perceptions of collaborative writing when using digital interaction and communication tools. They examined whether age, gender, digital competence, interest in digital tools, choice of tools, and educational context impacted how preservice teachers assessed the co-writing tools and how effective the tools were for working in groups. Their findings showed that preservice teachers with high levels of digital competence and positive attitudes toward the use of digital tools were more positive about collaborative writing, while gender had little significance on the preservice teachers' attitude toward collaborative writing (Brodahl et al., 2011). An interesting study of preservice teachers' preparation for using digital tools in schools revealed that the teachers found their training inadequate, and that the school's digital practice was challenging for the preservice teachers (Ajayi, 2010).

Another interesting study Morreale et al. (2015) on first-year college students' attitudes toward and perceptions of communication media and technology and found that the students preferred face-to-face communication. This study is, however, not specifically on teacher education.

Thus, the previous research has highlighted a lack of connection between what is stated about digital competence in international and national plans for teacher education, what is happening in school practice, and the preservice teachers' experiences of their learning of digital competence in their teacher education. The research also identified several important factors for developing preservice teachers' digital competence during their studies. However, little attention has been paid to the level of knowledge of digital sharing and communication students have when they start their teacher education and the factors that impact their knowledge. However, such competence is highly relevant for improving the flexibility of teacher education, both today and in the future. Accordingly, the aim of this article is to contribute to filling the knowledge gap in this field.

Theory

Social constructivist learning theory and interaction and communication

There are some distinctions between face-to face communication and online communication, but in this empirical study, we focus on digital communication and interaction. By digital interaction and communication, we refer to software tools such as Zoom, Teams, Sutori, Creaza, Minecraft, and Padlets. Students can use these tools to share content, such as documents, texts, and videos. They can communicate orally and in writing and collaborate in real time and whenever it suits them. They can make videos, cartoons, podcasts, mind maps, timelines, and stories. They can also play games, create questionnaires, and conduct polls in collaboration with one another. By sharing these products with each other, they can also improve their learning and obtain new insights. To support this, it is necessary to know what digital interaction and communication skills and competence students already have. Social constructivist learning theory forms the background of our study because it relates to the connection between collaboration and communication in order to develop learning and construct new knowledge. From a constructivist perspective, people learn through experience and construct their own knowledge through their interactions with the world (Biggs, 1999, p. 7). Furthermore, they construct this knowledge and understanding based on what they already know or believe (Bransford et al., 2000).

According to Vygotsky (1978), social interaction and linguistic activity are important for learning, and social actions are necessary to develop higher mental processes (Dysthe & Igland, 2001). The social aspect of learning is captured in Vygostky's concept of the proximal development zone, which refers to the distance "between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). This means that while people can achieve a certain degree of learning on their own, they achieve more

knowledge and greater understanding if they work with others who are more knowledgeable than they are.

Thus, learning and development entail active participation and collaboration with meaningful others while building upon existing knowledge. This means that teachers should either build on students' existing understanding or challenge that understanding (Bransford et al., 2000). Teachers should both make use of and relate to students' knowledge rather than perceive students as "empty boxes" (Freire, 1999). Teachers should help students use their abilities and existing knowledge in new situations (Beach, 1999). Humans are dependent on communicating with others in order to learn. According to Biggs (1999), it is important for students to collaborate and be in dialogue with each other and their teachers, as it is precisely this productive dialogue that shapes and deepens their understanding. Productive conversation also has consequences for teaching and teachers in teacher education because it requires them to meet students at the students' own level. Teachers should provide students with opportunities and tools for communication and interaction that can foster dialogue and collaboration, which, in turn, will increase their capacity for learning. Below we present our theoretical model.

Dependent variable: competence in digital interaction and communication

Based on the learning theories discussed above, as well as the importance of collaboration and communication for learning, we chose *competence in digital interaction and communication* as the dependent variable for our study. It follows that preservice teachers who have this competence will also have a sharing culture in which they learn more when they work with one another. Students who are educated in a sharing culture may find it easy to expand communication spaces and develop networks in which learning can take place in school (Utdanningsdirektoratet, 2018).

Jahnke and Nordberg (2013) used social constructivist learning theory and Vygotsky's proximal development zone as their starting points when developing their digital didactic design to promote student learning. Collaboration, interaction, and communication are particularly important for promoting learning through the use of digital technology: "Deeper learning will take place and with greater benefit when teachers and students collaborate and help each other" (Johanson & Karlsen, 2018, p. 14). At the same time, it is important that students learn with and not from technology. Jahnke and Nordberg (2013) point out that with the use of technology, the teacher's role changes, as they are required to facilitate active student learning to a much greater extent. In turn, students should be co-producers of knowledge and not just consumers of it, which is entirely in line with social constructivist views of learning. According to Jahnke and Nordberg (2013), learning is precisely about learning together or what they call the "co-creating of new knowledge" (p. 4). Thus, learning is a social process. Moreover, studies have shown that when used correctly, digital tools can provide access to productive opportunities for learning through shared resources, collaboration, and shared reflection (Jahnke & Kumar, 2014; Kongsgården & Midtbø, 2014). According to this view of learning, interaction and communication tools are significantly *more* important in a digital and flexible classroom, and students' competence in using them will have an impact on what

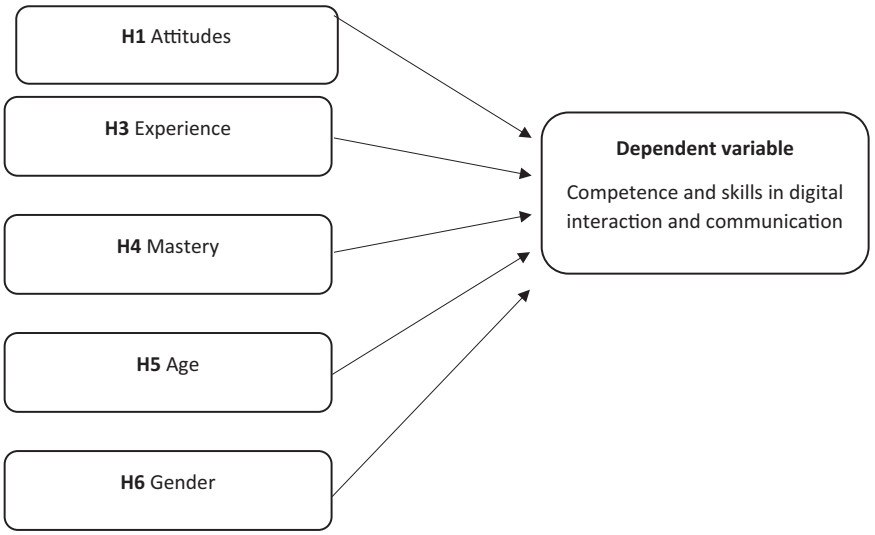

Figure 1. Analytical model with hypothesis numbers (H).

they learn. Thus, whatever influences their competence will be particularly important for their educational learning.

The key concepts used in our study are related to the learning theory presented above. Our dependent variable is *competence and skills in digital interaction and communication*. "Skills" can be regarded as something that can be acquired, whereas "competence" refers to the total ability a person has, for example, to acquire a skill. According to the Norwegian Directorate for Education and Training, competence means "acquiring and using knowledge and skills to master challenges and solve tasks in familiar and unfamiliar contexts and situations" (Utdanningsdirektoratet, 2018, p. 11). As a concept, competence can be understood and operationalized differently depending on the context in which it is used. In this article, we understand competence as a combination of skills and the ability to apply and reflect on them. Figure 1 shows the factors that we hypothesized could influence students' competence in digital interaction and communication.

Independent variables

For this study, we emphasized selected factors that we assumed would predict students' digital competence when they started their formal education at university. Therefore, our independent variables were linked to the concepts of *attitudes*, *emotional engagement*, *experience*, and *mastery*. We wanted to study whether and how these variables contributed to students' competence in digital interaction and communication. In addition, we chose *gender* and *age* as key control variables. In the model, we assume that our independent variables predict or contribute to our dependent variable. However, we were unable to control all relevant variables. Therefore, we cannot make claims about causal relationships.

We argue that students' attitudes toward digital interaction and communication are important when they start their education. We understand attitude as an individual's

opinion, perception, or approach with respect to a particular phenomenon. Attitudes are formed through people's perceptions of the world around them and how they assess phenomena considering the attitudes (and values) they acquire during their development (Rokeach, 1973). To measure attitudes, we took items 5–9 in the questionnaire as a starting point (see the Appendix for a description of all items, factor loading, and Cronbach's alpha). The five statements about attitudes were designed to measure students' perceptions of digital tools, their learning from sharing and communication tools, their digital collaboration, and their interest in using these tools. Our first hypothesis (H1) was that the above-mentioned factors contribute to students' digital competence.

Our second hypothesis was that engagement in the learning process is a crucial factor contributing to competence in interaction and communication. Engagement presupposes both motivation and a willingness to learn. Illeris (2012) refers to this as the "driving force dimension" of learning and claims that this and the cognitive and relational aspects of learning constitute the three dimensions of learning. To measure engagement, we formulated statements (items 14–17) (see the Appendix) to discover what motivated students to engage with digital technologies, such as whether it was "exciting to interact through digital tools" (item 14). We assumed an association between positive engagement with the learning process and students' competence in digital sharing and collaboration in their studies. This was our second hypothesis (H2).

The third independent variable in our study concerns the student t teachers' experiences during their primary and secondary education before they started their teacher education. This variable was chosen based on the idea that no one enters a learning situation without a knowledge base (Freire, 1999); rather, learners bring with them experiences that constitute their previous practice and that can be built upon in their future learning. We wanted to understand how students' experiences contribute to their digital competence in the first year of their education. With items 18–22, we asked students to comment on a variety of experiences, such as giving feedback to others and sharing their work. We also examined where the students had acquired their experiences, distinguishing between primary and lower secondary school education on the one hand and upper secondary school education on the other. Thus, hypothesis 3 (H3) was that preservice teachers' previous educational experiences contribute to their digital communication and sharing competence.

The fourth independent variable in our study concerns preservice teachers' expectation of mastering digital sharing and communication. We focused on students' own perceptions of their level of digital competence and how their mastery expectations affected their digital interaction and use of communication tools. We hypothesized that belief in one's own mastery, also called self-efficacy (Bandura, 1997), affects how individuals handle tasks. We examined this with items 26–29, which included statements such as "I often think that I am not good at using digital sharing and communication tools" (item 27). During the analyses, the order of the items was reversed to simplify the interpretations of covariances. Our fourth hypothesis (H4) was that positive mastery expectations contribute positively to students' digital sharing and collaboration competence.

We also hypothesized that a student's age could have an influence on their digital competence in communication and interaction. For example, we asked whether younger

Table 1. A summary of hypotheses.

H1	Positive attitudes predict competence in digital interaction and communication tools
H2	Emotional engagement predicts competence in digital interaction and communication tools
H3	Previous experience predicts competence in digital interaction and communication tools
H4	Mastery expectations predict competence in digital interaction and communication tools
H5	Age is significant for competence in digital interaction and communication tools
H6	Gender is significant for competence in digital interaction and communication tools

students might have had more experience with using digital tools in school than older students. Thus, for hypothesis 5 (H5), we assumed a correlation between younger age and digital competence. We also assumed that a student's gender could affect their competence in digital interaction and communication, which was our sixth hypothesis (H6).

Thus, our study consisted of six independent variables, which constituted factors that we assumed contributed to students' digital skills in terms of communication and interaction. These variables correspond to our six hypotheses, which are summarized in Table 1.

Methods

The questionnaire was developed based on two main themes:

1. Competence and skills in using interaction and communication tools
2. Competence in assessing sources.

These two themes were chosen because of their academic relevance in the social sciences. This article only examines the first topic.

When developing our questionnaire, we took as our starting point items the items used by Cantabrana et al. (2019) and Katheeb (2017), as well as those used in a survey conducted by Siiman et al. (2016). The development of scales built on a firm theoretical understanding of the theoretical concepts in all scales (see Table 1). When constructing items, we attempted to strike a balance between conceptual commonality and variety (Ringdal, 2013). These principles of commonality and variety were later tested statistically (see below). In adapting and writing the items, we aimed for concise expression and a variation of verbs and situations (see the Appendix).

While the items in the previous surveys mentioned above were valuable starting points, we adapted most items to the local context and took inspiration from the previous surveys to develop some new items. To be able to choose from a small pool of items in the statistical analysis, we constructed a few extra items than we needed for a good concept validity. The distinction between which items were "revised" and which were newly written is somewhat blurred. Therefore, we avoid being specific here and instead refer to our sources as particularly valuable contributions.

To optimize the students' opportunities to answer the questionnaire and ensure optimum variance, we constructed the questionnaire based on a 7-point scale for responses (Christophersen, 2012).

Prior to the survey, the questionnaire was tested on seven students. We then selected and adjusted the items to be used in the survey. The questions were written in Norwegian. We chose to include all preservice teachers in their first year of study in

primary school teacher education (programs 1–7 and 5–10) at both universities. The total sample included 395 students, consisting of 104 (population 110 and response rate 95%) students from one university and 291 (population 470 and response rate 62%) students from the other.

Due to a few missing responses which were excluded the sample was reduced to 375 students. A two-page paper questionnaire was distributed during teaching. The material was scanned by the IT department at one of the universities, which also generated the data file. At both universities, the sample was drawn at random and is therefore considered representative of students in all programs. All students were informed in writing about the project in advance and were given the option of not participating.

Analyses

All data analyses were performed using IBM's SPSS software and followed the detailed guide formulated by Christophersen (2012). We started by examining the distribution and measures of both skewness and kurtosis (Christophersen, 2012). Skewness and kurtosis were well within the margin of ±2.0 for all variables, which means that the distributions were well within the threshold for statistical analysis.

To ensure the largest possible sample, missing data (which were minimal) were replaced in the sample and assigned a value equaling the average of their nearest neighbors' mean (i.e., the means of the nearby points in IBM SPSS).

We performed semi-confirmatory factor analyses for all our concepts. We entered only the items relating to each concept in the analysis but allowed for more than one factor, which makes the analysis semi-confirmatory. All analyses of the concepts gave one factor (latent variable), and the loadings were, with a few exceptions, satisfactory (a loading of around .70 means that an item accounts for approximately 50% of variance in the factor, which corresponds well with the principles of unity and diversity; see the Appendix for all loadings). A definite lower threshold for a factor leading is .30 (Ringdal, 2013). The aforementioned exceptions included item 8, which accounted for 28% of the variance and item 20 which accounted for 20% of the variance in the concept (see concepts and items in the Appendix). These items are still considered valuable for their contribution to conceptual validity in our model (Ringdal, 2013).

We also examined Cronbach's alpha to measure the consistency of all our concepts and found the values satisfactory ($\alpha > .70$; see the Appendix). The outcome of the factor analyses and Cronbach's α was that we made a sum score for all the concepts, which were also our analytical variables (see the Appendix).

Based on the above procedures and results, we consider the scales used in this study to have good conceptual and statistical validity. We believe that this makes our results valid and reliable. The scales may, of course, be used by other researchers when and where applicable or modified according to local needs.

We started the analyses by performing bivariate correlations between the dependent and independent variables (see Table 2). We then performed multiple regression analyses of the same variables using ordinary least squares and the 'ENTER' method, which means variables were entered simultaneously (see Table 3). The purpose of the analyses was to determine the extent to which the independent variables contributed to the

Table 2. Bivariate correlations between the dependent variables (digital competence in interaction and communication) and independent variables with corresponding hypothesis number.

	Variable	Pearson's r	P (probability of significance)
H1	Positive attitudes toward digital interaction and communication tools	.53	.000
H2	Emotional engagement	.46	<.001
H3	Previous digital experiences	.56	<.001
H4	Mastery expectations	.41	<.001
H5	Gender	.01	.88
H6	Age	−.04	.731

Table 3. Multiple regression analysis of the dependent variable (digital competence in interaction and communication) and the six independent variables.

	Variable	Standardized regression coefficient β	P (probability that the null hypothesis applies)
H1	Positive attitudes toward digital interaction and communication tools	.29	<.001
H2	Emotional engagement	.11	.033
H3	Previous digital experiences	.29	<.001
H4	Mastery expectations	.14	.002
H5	Gender	−.08	.61
H6	Age	−.12	.003

Note: Adjusted for r^2 .44 or 44% of the variance in the dependent variable.

variance in the dependent variable. In the multiple regressions, we controlled for the effect of all the independent variables.

Ethical considerations

The researchers confirm that the content, procedures, strengths, and limitations of the present study are fully transparent and that no deliberate attempts have been made to hide or modify information. All participants were informed about the aims and procedures of the study, and participation was voluntary. No participant was underaged, and the questions asked in the study avoided personal or difficult themes. The students were guaranteed anonymity, and their responses could not be traced to them directly or indirectly. Data were secured and stored behind passwords. The study complies with the research ethics guidelines formulated by the Norwegian national committees (NREC, 2019).

Results

We estimated the bivariate correlations between the dependent variable and all the independent variables. The dependent variable was the sum score for *competence in using digital interaction and communication tools* (see Table 2).

Except for gender, all the independent variables showed a relatively strong (r >.40) correlation with the dependent variable *digital competence in interaction and communication*. We found a relatively strong bivariate correlation between *attitude* and *digital competence in interaction and communication*, which supported our first hypothesis

(H1). We identified a similar (but slightly weaker) correlation between *emotional engagement* and *digital competence in interaction and communication*, which supported our second hypothesis (H2). Furthermore, we observed a strong bivariate correlation between *previous experience* and *digital competence in interaction and communication*, which supported our third hypothesis (H3). Lastly, we found a medium correlation between the belief in one's ability to master the use of digital tools (mastery expectations) and *digital competence in interaction and communication*, which supported our fourth hypothesis (H4). No bivariate correlations were found between either *gender* or *age* and *digital competence in interaction and communication*. Therefore, our fifth and sixth hypotheses (H5 and H6) were not supported. The fact that four of the independent variables correlated with the dependent variable, *digital competence in interaction and communication*, shows that this competence can be stimulated in different ways (see "Further implications" below).

We then estimated the multiple regression, which controlled for the effects that the other variables in the regression had on the dependent variable in the model (see Table 3).

In general, three variables had a significant explanatory role in our model: *positive attitudes toward digital interaction and communication tools*, *previous digital experiences and emotional engagement*. The results of the regression analysis showed that the variable attitudes was relatively strong in predicting the dependent variable ($\beta = .29$) and thus in supporting H1 when controlling for the other variables in the regression. Therefore, the variable clearly predicted *digital competence in interaction and communication* when controlling for the other variables. The second important variable, *digital experiences*, also predicted competence in digital interaction and communication (H3) when controlling for the other variables. The variable *emotional engagement* was only moderately predictive of the dependent variable ($\beta = .11$). It was still significant (when controlling for the other variables) but provided weak support for H2. Similarly, the variable *mastery expectations* were only moderately predictive of the dependent variable (when controlling for the other independent variables) but was still significant and provided weak support for H4. Gender was not significant and had no influence on digital competence; thus, there was no support for H5. Age showed a negative correlation, indicating that younger students were slightly more competent in using digital sharing and communication tools compared with the slightly older students. This result provides moderate supstudentport for H6. Overall, the independent variables explained 44% of the variance in the dependent variable, which was substantial. These results are discussed further in the next section.

Discussion

We started this article by asking what factors could explain the variation in preservice teachers' digital competence in interaction and communication.

The results of the multiple regression revealed that the preservice teachers' attitudes toward digital interaction and communication tools was one of the most important variables in our study. This variable had the greatest effect on students' competence in using digital interaction and communication tools. This result shows that for many

students, digital collaboration is highly dependent on their attitude toward working with one another and that actual competence in connecting with other students seemed to be less important. For many students brought up in the digital world, their attitudes toward using this communication and sharing tools might be dependent on the usefulness and relevance of the tools for their future school practice.

The significance of students' previous experiences with digital interaction and communication tools was also clearly reflected in the results. We see students' experiences with and attitudes toward digital communication tools in schools as mutually interdependent. The quality of their experience shapes their attitudes, and their attitudes continue to shape their future experiences. This is in line with previous findings highlighting that the effective use of digital tools provides productive opportunities for learning through sharing and collaboration (Jahnke & Kumar, 2014; Kongsgården & Midtbø, 2014).

Expectations of mastery generally play a significant role in most aspects of life. However, mastery expectations contributed only moderately to students' digital collaboration and communication competence. This underlines that the quality of students' experiences, such as achieving mutual gains in collaboration, seems to be more important than overcoming technical challenges in digital collaboration. Thus, expectations of mastering digital collaboration are less critical than the use of sharing tools for most students; however, this mastery expectation's moderate but significant effect should not be ignored. These results imply that in every group of students, there is likely to be a minority who do not feel confident in using digital tools. These students may struggle technically and may therefore avoid using such tools. Thus, for such students, the threshold for using digital tools will be higher, and they might need extra support in their higher education.

The preservice teachers' emotional engagement in their digital learning processes seemed to be less important, which suggests that only a minority of students will still have an advantage if they are deeply engaged in working digitally. Conversely, students who do not become excited about digital tools (or even review them) may be somewhat disadvantaged when using digital platforms. Therefore, it seems that the quality of students' experiences is of vital importance for their use of these platforms and their enthusiasm for sharing and communicating digitally.

Our results also showed that older students experienced greater challenges in relation to digital collaboration and communication competence than younger students. The age range of the students in our survey was between 19 and 36 years. The younger students perceived themselves to be more competent in digital interaction and communication tools than the older students in the survey. This is promising for future digital collaboration in teacher education.

Lastly, men's and women's digital communication competence was evenly distributed, which is somewhat surprising. This fact might be explained by men's and women's equal use of digital tools and platforms during their upbringing and in their education.

Implications for teaching

In our recommendations for teaching, we argue that teacher educators are role models in teacher education. Acting as a good role model is the best way to support good

practice and promote positive attitudes and patterns of behavior (Bandura, 1997). When using digital tools, teachers should be sensitive to the balance between digital and human interaction and collaboration and avoid overuse of digital technologies. We argue that conversation and collaboration form the basis for teacher practice but that digital collaboration tools (software) can add value, such as offering opportunities to share, comment, challenge, or otherwise pursue collaboration and knowledge development. Good practice means emphasizing the learning value that digital technologies add, such as preparing preservice teachers for practice in schools. Providing preservice teachers with positive experiences in their education is good "modeling" and is important for meaningful practice in school. Examples of positive experiences can be the feeling of mastering and understanding digital tools. We also emphasize that the use of tools should be "authentic" and that their use facilitates or is considered valuable by students.

Furthermore, teacher educators should reflect on and perhaps justify their use of digital practice and refer to theories of leaning, which are always at the heart of teacher education. We also argue that some coordination among teacher educators should take place. Coordination might imply the use of relevant digital tools in most subjects to enhance preservice teachers' experiences and support their digital learning. We believe a moderate level of coordination of teacher educator practice should also model the need for collaboration and coordination between teachers in schools and should reduce the rather individualized practice experienced in teacher education today.

In accordance with our modeling argument above, we recommend that teacher educators build on students' positive attitudes (i.e., when acting as good models of pupils' attitudes in school) because such attitudes can motivate them to learn in collaboration with others. This is entirely in line with the social constructivist learning theory, which holds that learning is built through collective interaction. To further improve students' attitudes, we recommend facilitating the use of tools that give students more positive experiences. Building on our experience as teacher educators using the tools mentioned earlier, namely Zoom, Teams, Sutori, Creaza, Minecraft, and Padlet, we emphasize that the tools should be relatively intuitive to be sufficiently accessible for pupils in school as well as for preservice students and teacher educators. Some students may find intricate or complex interfaces challenging, which may cause them to abstain from further collaboration. Based on our observations of several lessons involving the use of digital tools, we believe that there is a connection between students' positive attitudes and the level of facilitation.

Digital developments are occurring at a high pace, and new digital platforms are continually being introduced in schools, which underlines the need for digital practice. As this study shows, students' experiences with using digital tools vary. To be able to meet these students' needs and provide them with positive experiences, it is important to choose tools that are adapted to their level of competence. Teacher educators also need to support students by acting as good role models who guide and support struggling students (see Bandura, 1997, on vicarious experiences of self-efficacy). We also recommend a systematic plan for students' digital progression.

Good practice includes being a positive role model and paying particular attention to authenticity, relevance, and value added using digital communication tools. Such

practices enhance the quality of students' experience and promote the sensible use of digital tools.

Conclusions

The following conclusions can be drawn from this study:

- First-year preservice teachers' attitudes clearly contribute to their competence in digital interaction and communication at the start of the academic year.
- First-year preservice teachers' previous experiences contribute to their competence in digital interaction and communication at the start of the academic year.
- Emotional engagement makes a weaker contribution to preservice teachers' competence in digital interaction and communication. Nevertheless, such engagement is important for a minority of students.
- Preservice teachers' mastery expectations (i.e., their belief that they can master various digital interaction and communication tools) contribute less to their use of such tools. However, such expectations are important for a minority of students.
- Gender is not a significant factor in preservice teachers' competence in digital interaction and communication.
- Age has some significance for preservice teachers' competence in digital interaction and communication. Younger students seem to have slightly lower thresholds for the use of interaction and communication tools than older students.
- Teacher education must support the sensible use of interaction and communication tools to strengthen new preservice teachers' digital communication competence.
- Teacher educators need to be good role models who use digital tools constructively and critically.

Overall, we argue that teacher education should facilitate active and meaningful use of interaction and communication tools that are adapted to preservice t teachers' existing competences. By 'meaningful', we emphasize that digital communication must support students and be relevant for their education and relatively easy for them to use. Good digital practice can strengthen preservice teachers' learning throughout their education.

One implication of our study is that future research should identify measures that can contribute to preservice teachers attaining roughly the same level of competence in digital technologies when they start their education. If students have the same starting point, the probability of their achieving their academic goals will be strengthened. Another implication of our study is the need to encourage students to develop good routines involving collaborative use of digital interaction and communication tools to develop their digital competence.

Today, we are experiencing rapid and unforeseen changes that affect how the field of education is designed and organized. In the future, teacher education is likely to become increasingly flexible, which will require knowledge of students' competences when they

start their education to strengthen their competence in digital interaction, collaboration, and in-depth learning.

Limitations of the study

One limitation of our study is that although our sample was large, it represented only one type of education. Therefore, the findings cannot be generalized to teacher education throughout Norway. Nevertheless, as there were 395 students in our sample, we assume that we achieved good variance in the sample and that similar results could be found in other samples of first-year preservice teachers in Norway. A second limitation is that our conceptual goals overlapped to some extent. Therefore, our results were less precise than expected. Finally, some variables were not included in our model. We suggest that more research is needed to gain more insight into what contributes to students' digital interaction and communication competence.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix. Item Text, Factor Analysis, and Cronbach's α for the Concepts Used in the Analyses

Item no.	Description	Factor loading	Cronbach's alpha (α)
	Attitudes toward digital interaction and communication tools		
5	I like the challenges that digital tools give me.	.65	
6	My learning is improved by my use of digital sharing and communication tools.	.76	
7	Digital sharing and communication tools promote collaboration.	.63	
8	Knowledge of digital sharing and communication tools is crucial for me as a future teacher.	.53	
9	I am interested in digital sharing and communication tools.	.75	$\alpha = .80$
	Use of sharing and communication tools		
10	I can use digital tools to share documents and files.	.64	
11	I often take the initiative to collaborate using digital sharing and communication tools.	.65	
12	I often use digital resources in communication and interaction.	.82	
13	I am an active user of several sharing and communication tools.	.74	$\alpha = .80$
	Emotional engagement		
14	It is exciting to interact through digital tools.	.68	
15	I am happy when I learn about new technologies that can be used for learning and interaction.	.68	
16	I like to share my work with others.	.59	
17	When I use digital sharing and communication tools, I become easily engrossed in work tasks.	.74	$\alpha = .77$
	Previous experiences		
18	I have a lot of experience with digital sharing and communication tools.	.67	
19	I usually share work assignments digitally with others.	.53	
20	I often give feedback on others' work digitally.	.46	
21	I gained a lot of experience in the use of digital sharing and communication tools in primary and secondary school.	.65	
22	I gained a lot of experience in upper secondary school in the use of digital sharing and communication tools.	.76	$\alpha = .75$
	Mastery expectations		
26	I become insecure when I start using new digital sharing and communication tools.	.72	
27	I often think that I am not good at using digital sharing and communication tools.	.78	
28	My work is usually not good enough to share.	.43	
29	I prefer to avoid taking responsibility for digital collaboration.	.57	$\alpha = .72$