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THE ROLE OF DIGITAL EDUCATION TECHNOLOGIES IN THE DEVELOPMENT OF DIGITAL COGNITIVE COMPETENCIES OF TEACHERS: AN ANALYTICAL STUDY FROM THE POINT OF VIEW OF PEDAGOGICAL EXPERTS

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ABSTRACT

Digital competence of teachers has become a decisive point of the successful implementation of digital technologies in modern education. The fast growth of digital education implies that teachers need to have digital cognitive capabilities that can help them to apply digital technologies to teaching and professional practices. Nevertheless, much research is of the value of how digital education technologies can help develop these competencies. The proposed study attempts to explore the impact of digital education technologies on the formation of digital cognitive abilities of teachers through the lens of pedagogical professionals. The descriptive analytic method was employed, and data were collected through a structured questionnaire of the pedagogical experts in relation to education and educational technology. This instrument was used to measure some of the dimensions of digital cognitive competencies of teachers such as digital information literacy, digital communication and collaboration, digital critical thinking, digital problem solving, and digital content creation. The findings suggest that digital education technologies are significant in assisting the growth of the digital cognitive competencies of the teacher. The results also demonstrate the significance of professional growth and institutional assistance in enhancing digital competence of teachers and advancing efficient use of technology in classroom settings.

KEYWORDS: Digital education technologies · Digital competence · Digital cognitive competencies · Teachers · Educational technology · Professional development.

1. INTRODUCTION

Digital technologies are rapidly evolving and this has contributed to a change in the modern educational systems that have presented new opportunities and challenges in the teaching and learning processes. Schools and colleges are rapidly incorporating digital technology, online learning, and technology-based learning into their instructional methods and strategies to enhance better learning. Consequently, digital education has become part and parcel of the contemporary education, and teachers need to be equipped with advanced skills that will help them properly incorporate digital technologies into their professional activities.

The digital technologies have transformed the conventional role of a teacher by altering the teaching methods where the teachers were involved in teaching that mostly were teacher-oriented to more interactive, collaborative and student-oriented environments. In these situations, teachers are not only supposed to utilise digital tools but they should also create new learning activities, administering digital learning environments and helping the students to develop their own digitally. As a result, the principle of digital competence has become one of the major demands of instructors in the contemporary educational environment of the twenty-first century (Falloon, 2020; Scherer et al., 2021).

Teacher digital competence can be defined as a body of knowledge, skills, attitudes, and professional practices that help teacher to successfully use digital technologies in the areas of teaching, assessment, communication, and professional development. This skill goes beyond the technological skills and encompasses the pedagogical, cognitive, and ethical aspects of the incorporation of digital technologies into the instructional methods (Redecker, 2017; Pettersson, 2018). Studies indicate that highly digitally competent teachers can be better placed to create meaningful digital learning and to assist students in negotiating digital environments of information.

Over the past years, a number of frameworks have been constructed to the conceptualization and assessment of digital competence of teachers. The Digital Competence Framework of Educators (DigCompEdu) that defines the major domains of digital competence in the professional engagement, digital resources, teaching and learning, assessment, empowering learners, and supporting the development of digital competence in students is one of the most popular frameworks (Redecker, 2017;

Lucas and Moreira, 2017). These frames put the emphasis on the multidimensionality of digital competence and the necessity to combine pedagogical, technological, and professional knowledge in the practice of teachers.

Another issue also closely connected with the use of digital technologies in the educational sector is the formation of digital cognitive competencies of teachers, including higher-order skills, such as information analysis, the creation of digital content, critical thinking, and problem-solving on digital grounds. These skills will help teachers to adequately make sense of digital information, create digital learning materials and make sound pedagogical choices in using technology in teaching. Research shows that teachers experience with the digital technologies, professional training, and institutional support determine the development of such competencies (Hämäläinen et al., 2021; Peters et al., 2022).

Even though there has been an increased significance of digital competence in education, most educators still grapple with the issue of successfully incorporating digital technologies in their instructional practices. It has been found that the effective use of digital technologies in education is determined by a number of factors, such as beliefs of the teachers and their trust in using technologies, the access to professional development opportunities, and support by institutions (Ertmer and Ottenbreit-Leftwich, 2010; Althubyani, 2024). In most of the schools, trainings and support are not properly provided, which restricts the capabilities of teachers to use the digital technologies to the fullest in their pedagogical tasks.

Moreover, the past research shows the development of digital competence demands uninterrupted professional learning and cooperation between teachers. Online communities, professional learning networks, and online training programs may be useful in preserving the professional development of teachers and assist them in acquiring the required skills to survive in the digital setting that changes fast (Trust, 2018; Johannesen et al., 2024). Thus, it is important to know how digital education technologies can be used to enhance the development of digital cognitive competence in teachers in order to enhance teacher training and professional development courses.

In this regard, the digital education technologies are a valuable resource in the context of developing professionalism of teachers. These technologies make various educational materials and interactive learning platforms, collaborative tools available to

teachers to support teaching practices and their learning. With the help of such technologies properly used, the digital cognitive competencies of teachers can be developed, as it will allow them to participate in new teaching activities and respond to the requirements of digital education.

Based on this, the proposed research is expected to investigate how digital education technologies can be used in the formation of digital cognitive skills of the teacher through the eyes of pedagogical specialists. Through the expert opinion analysis, the study is aimed at giving information about how digital technologies may be utilized to benefit the professional growth and increase the capacity of teachers to successfully incorporate digital tools in modern classrooms.

2. THEORETICAL BACKGROUND

2.1 *Digital competence in education*

The high rate of digital technological development has greatly reconfigured the education system across the world. Schools are becoming more and more dependent on digital resources, online learning, and technology-mediated learning environments to facilitate the teaching/learning processes. Consequently, educators will be supposed to have high-level skills that will allow them to implement digital technologies in their learning processes and adjust to the needs of digital learning. In turn, digital competence has taken a leading role in contemporary education and made it a primary necessity to teachers of the twenty-first century (Scherer et al., 2021; Revuelta-Dominguez et al., 2022).

Digital competence usually refers to the capability to critically, creatively, and responsibly utilize digital technologies to gain access to information, communicate, collaborate and generate knowledge. In an educational setting, the concept is not limited to technical skills but also encompasses pedagogical, intellectual, and ethical factors that make teachers be able to incorporate technology into the teaching and learning processes. Educators should, hence, be able to create digital learning activities, find the right technological tools, control digital learning contexts, and assess the learning of students with the help of digital technologies (Pettersson, 2018; Moreira et al., 2023).

It is not a new trend in the recent years that researchers started underlining the significance of digital competence as one of the key professional demands of an educator. Teachers are not only supposed to apply digital technologies in their teaching but also to assist students to acquire digital

skills required of them when they are in the modern society. In this respect, educators can be very instrumental in equipping students to live in a digital world that undergoes continuous technological development and is rife with the use of digital information (Hämäläinen et al., 2021; Nagel, 2025).

Various researches suggest that digital competence of teachers is a crucial factor in the success of technology implementation in education. More digitally competent teachers can better create an interactive learning environment, encourage collaborative learning, and introduce new teaching methods that allow students to become more engaged and motivated (Demissie and Rorissa, 2022; Diaz-Garcia et al., 2024). However, teachers who are poorly digitally competent usually cannot effectively apply technology in the classroom and this minimises the possible educational potential of digital tools.

An additional dimension of digital competence touches upon the concept of digital cognitive competencies that imply the higher-order thinking skills to be used in order to be competent in digital space. These are analytical skills on digital information, the ability to create digital content, solve problems with the help of digital tools, and understand the credibility and applicability of information on the web. With such competences teachers are in a better position to design meaningful digital learning experiences, as well as to lead students through digital information environments (Hatlevik et al., 2015; Hu et al., 2025).

Studies also point to the fact that the digital competence of teachers depends on a number of personal and contextual factors. These variables are the technological self-efficacy of teachers, their attitudes to digital technologies, the availability of the opportunities of professional development, and the organizational support of the integration of technologies. Those teachers who positively believe in the usefulness of the digital technologies and who are confident in their use tend to integrate the digital tools in their practices (Ertmer and Ottenbreit-Leftwich, 2010; Althubyani, 2024).

In addition, digital competence development is strictly connected with the professional development of teachers and their life-long learning. With the ever changing digital technology, teachers need to continuously upgrade their skills and knowledge in order to remain a successful teacher. Online courses, workshops, and collaborative professional networks are also examples of professional learning that are important in assisting teachers to develop digital competence (Peters et al., 2022; Johannesen et al.,

2024).

Moreover, the process of the digitalization of education presupposes the implementation of new pedagogical practices among teachers that would focus on active learning, collaboration, and student-centered teaching. Using digital technologies, personalized learning, blended learning, and online education open some chance to improve the learning experience of students in case they are implemented successfully. The effectiveness of these strategies, however, is highly determined by the digital competence of teachers and their skills to use technology in their instruction in significant ways (Means et al., 2013; Starkey, 2020).

Moreover, the increasing significance of digital competence as an educational tool has caused the interest in the research of how teachers acquire and acquire the latter and how they can be facilitated through training and professional development programs. Research indicates that institutional support, digital resources, and teacher training programs are critical in promoting the growth of teachers in terms of digital competence (Instefjord and Munthe, 2017; Osorio Vanegas et al., 2025).

Overall, digital competence is a multidimensional construct, which encompasses technological, pedagogical, cognitive, and professional aspects. Digital competence of teachers is crucial towards better teaching, increased student learning outcomes, and successful adoption of digital technologies in the modern education system.

2.2 Frameworks of teachers' digital competence

Due to the increased significance associated with digital competence in the education sector, there has been a series of frameworks created with the view of conceptualizing and assessing the digital competencies teachers need. These frameworks offer systematic models within which educators, researchers, and policymakers can learn more about the different aspects of digital competence and direct teacher training and professional development programs (Cabero-Almenara et al., 2020; McGarr and McDonagh, 2024).

The European Framework of the Digital Competence of Educators (DigCompEdu) is one of the most well-known frameworks in the area. This framework was created to help teachers learn and acquire the skills needed to be effective teachers in an online classroom. DigCompEdu distinguishes between six areas of digital competence, namely, professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating digital competence in learners (Redecker,

2017; Lucas and Moreira, 2017).

DigCompEdu framework underlines that the digital competence of teachers does not only relate to the capacity to use digital technologies. Rather, it emphasizes the need to incorporate digital technologies in pedagogical methods in a manner that helps to improve the learning processes. Educators should be capable of choosing the relevant digital tools, creating technology-based learning tasks, evaluating learners with the help of digital resources, and helping learners to develop their digital skills (Revuelta-Dominguez et al., 2022).

The Technological Pedagogical Content Knowledge (TPACK) model is another model that has had an impact in the area of educational technology. The model focuses on integrating three critical forms of knowledge, which include: technological knowledge, pedagogical knowledge and content knowledge. In this scheme, a successful technology integration happens when instructors can integrate these forms of knowledge in such a way as to create meaningful learning experiences that can be used to enhance student learning (Koehler and Mishra, 2009; Voogt et al., 2015).

TPACK framework illuminates the difficulty of integrating technology in education. It is important that the teachers are not only familiar with the technological tools that they are utilizing but also know how the tools can be applied to teach certain subjects content and pedagogy. The interplay of technologies, pedagogical, and content knowledge allows teachers to design learning settings that can effectively use digital technologies to facilitate the learning of students (Smestad et al., 2023).

Besides DigCompEdu and TPACK, other frameworks that focus on various facets of digital competence of teachers have been proposed by several researchers. Other frameworks are based on the collaboration, professional learning network, and continuous professional development of the teachers, as their professional digital competence (Skantz-Abegny et al., 2022; Johannesen et al., 2024).

Digital competence models also put significant emphasis on digital assessment, digital collaboration, and digital content creation as essential elements of professional practice of a teacher. Indicatively, in digital learning settings, teachers should be in a position to apply digital assessment tools to track the learning process of students and give feedback to students (Siddique et al., 2016).

Moreover, such frameworks also tend to focus on the ethical and social dimensions of digital competence, such as responsible use of the technology, privacy, and digital citizenship.

Educators are expected to know the ethical aspect of using technologies and help students to build responsible digital behavior (Pettersson, 2018).

Studies further reveal that platforms of digital competence are significant in informing educator education programs and professional training. Digital competence models are increasingly becoming part of the curriculum of teacher education institutions with an aim of making future teachers acquire the necessary skills to teach in a digital setting (Tondeur et al., 2017; Starkey, 2020).

Furthermore, the digital competence frameworks can be helpful at measuring the level of digital competence among the teachers and letting the latter know in which areas to improve. These frameworks can be used by educational institutions to determine the digital skills of teachers and implement specific training programs to enhance technology integration in education (Aydin, 2024; Tzafilkou et al., 2023).

Altogether, digital competence frameworks help to gain a deeper insight into multifaceted skills that can be used to teach effectively in digital settings and offer great assistance to the professional growth of teachers.

2.3. Development of Teachers' Digital Competence

The exploration of the digital competence of teachers is dynamic and an ongoing process that is shaped by some of the personal, institutional, and technological factors. Teachers learn to be digitally competent in the course of formal study, professional development initiatives, through teaching practice, and collaboration with colleagues. With the ever-growing pace of the development of digital technologies, teachers are forced to constantly improve their skills and knowledge to apply them properly into their teaching process (Pablos et al., 2022; Salehi et al., 2025).

Professional development is a key factor in assisting the development of digital competence of teachers. The training programs that emphasize on the pedagogical exploitation of digital technologies are especially efficient in assisting teachers in incorporating technology in lessons. With these programs, teachers get a chance to test the digital tools, experiment with novel approaches to teaching and gain confidence in the use of digital technologies in their classrooms (Lawless and Pellegrino, 2007; Peters et al., 2022).

The use of collaborative learning conditions is also emphasized to support the development of digital competence of teachers. The involvement in professional learning network, online community,

and collaborative projects can also help teachers to share experiences, discuss challenges, and exchange best practices related to technology integration (Trust, 2018; Olofsson et al., 2017).

Attitudes and beliefs that teachers have towards technology are also important in the process of developing digital competence. Educators who consider digital technologies as helpful and applicable to teaching have better chances to implement them into the teaching process. Conversely, educators with low confidence in their technological skills would not be eager to use digital technologies in their education (Ertmer and Ottenbreit-Leftwich, 2010; Hu et al., 2025).

Technological self-efficacy is another critical issue that can affect the development of the digital competence of teachers. When teachers become confident that they can utilize digital technologies, they tend to experiment with them and introduce them into their instructional methods. On the other hand, educators who have a low technological self-efficacy might not want to use digital technologies out of the fear of failure or they lack the confidence (Hatlevik et al., 2015).

The role of the institutional support in enhancing the growth of the digital competence of teachers is also critical. Schools and colleges should equip proper technological infrastructures, access to digital materials and offer ongoing opportunities of providing professional training. In the absence of it, teachers can have serious difficulties with acquiring the necessary skills to integrate technology successfully (Althubyani, 2024; Momdjian et al., 2024).

Also, the new possibilities of teachers to engage in professional development are provided by the presence of digital learning materials and online learning platforms. Teachers are able to take online courses, webinars, and virtual workshops that allow them to access new knowledge and strategies of teaching. Such digital learning possibilities allow educators to ever-enhance their digital skills and become accustomed to the new learning tools (Kaliisa & Picard, 2017).

Education programs regarding teachers are also necessary to equip future teachers with digital teaching conditions. To make sure that the newly graduated teachers are ready to use digital technologies in their instruction, universities need to introduce training on digital competence into the teacher education programs (Instefjord and Munthe, 2017; Tondeur et al., 2017).

Moreover, reflective teaching practices are directly related to the development of the digital

competence of teachers. The more often teachers analyze their teach back strategy and consider the efficiency of digital technologies in their classes, the more likely they will become more digitally competent in the long run.

To sum up, the formation of digital competence of teachers has to be a complex synthesis of professional education, organizational assistance, educational cooperation opportunities, and lifelong education. Knowledge of the factors, which determine the development of digital competence, is key to the development of effective teacher training programs and encourages the successful implementation of digital technologies in education.

2.4. Research Questions and Hypotheses

According to the theoretical framework and the prior research done on the digital competence of teachers and incorporating of digital technologies in teaching, the proposed study aims at investigating the role of digital education technologies in the emergence of digital cognitive competencies in teachers in the light of pedagogical experts.

The following research questions are therefore the attempts of the research:

RQ1: How does digital education technologies develop digital cognitive abilities of teachers in the eyes of pedagogical expert?

RQ2: What digital cognitive teacher competencies are the most affected by the application of digital education technologies?

RQ3: How can various types of digital education technologies be used to enhance the digital cognitive competencies of teachers?

Depending on these research questions and the theoretical background in this study, the following hypotheses were developed:

H1: Digital technologies in education play a significant role in the advancement of digital cognitive skills of teachers.

H2: The digital education technologies play a significant role in improving the digital information literacy of teachers.

H3: Digital learning technologies play an important role in digital communication and collaboration of teachers.

H4: Digital education technologies play an important role in the evolution of digital critical thinking of teachers.

H5: Digital technologies of education can play a significant role in the development of digital problem-solving skills in teachers.

H6: Digital education technologies play an important role in facilitating the capacity of teachers

to produce digital educational materials.

3. METHODOLOGY

3.1. Instrument

In order to explore the impact of digital education technologies on the formation of digital cognitive competencies in teachers, a structured questionnaire was created as the main data collection tool. The questionnaire has been created according to a rather large literature review concerning digital competence of teachers, digital education technologies and technology integration in the educational practice. The theoretical basis of assembling the questionnaire items was based on previous research and digital competence models (Redecker, 2017; Cabero-Almenara et al., 2020).

The questionnaire is expected to investigate the degree to which the application of digital education technologies can be used to advance the process of forming digital cognitive competencies of teachers in the eyes of pedagogical professionals. The tool features the questions that reflect various dimensions of digital competence development such as the application of digital resources in teaching, the role of digital technologies in facilitating the professional learning of teachers and the role of technology in developing the higher-order digital cognitive skills such as information analysis, creating digital content, and problem solving in digital contexts.

The questionnaire was also designed based on the prior studies regarding the digital competence of teachers and the integration of technology in teaching. These studies emphasize the necessity of evaluating the technological competency of teachers, as well as pedagogical and cognitive one when applying digital technologies in the teaching process (Scherer et al., 2021; Revuelta-Domínguez et al., 2022).

The questionnaire will have two major parts. The demographic section of the first part gathers data on demographics of the respondents such as academic specialization, years of experience at work, and institutional affiliation. The second section comprises the statements which are associated with the study variables. These assertions explore how the digital education technologies are perceived to support the professional practices of teachers and how they contribute to the acquisition of digital cognitive capabilities.

The measure was done under a five-point Likert scale (1 = strongly disagree) to (5 = strongly agree) into all questionnaire items. Such a scale is common in studies that are conducted in the field of education since the researcher can easily quantify the

perceptions and attitude of the participants towards certain issues in a scientific way (Siddique et al., 2016).

The instrument was tested by other experts in the area of educational technology and teacher education before issuing the questionnaire to the participants so

as to check the clarity, relevance, and validity of the questionnaire items. According to the feedback of the experts, certain changes were done to enhance the wording of certain statements and make the questionnaire clearly show the objectives of the study.



Figure 1. Conceptual framework of the instrument used to analyze the role of digital education technologies in developing teachers' digital cognitive competencies.

3.2 Sample Characteristics and Data Collection

The research sample of the current study was made of 45 pedagogical specialists working in the field of education, educational technology, and teacher training. These professionals were chosen due to their educational and professional background on assessing the educational practice and integration of digital technology.

It is important to point out that there were a few items on the questionnaire that were initially developed in first person (e.g., I use digital platforms in teaching or I develop digital learning materials). Though such a description is often applied in researches that are aimed at teachers, the respondents in the given research were pedagogical professionals and gave evaluative views of the practices used by teachers instead of describing their own practice.

In this regard, the meaning of the questionnaire items in this study was informed by the evaluative judgments of the experts concerning the practices and competencies of the teachers in the digital learning settings. The professionals were to answer

the items taking into account the level to which digital education technologies are effective in terms of developing digital cognitive competencies of teachers.

Such a method coincides with the research designs that offer the opportunity to evaluate educational practices and the effects of technological innovations on teaching and learning scenarios on the basis of expert evaluation and professional judgment. However, in the future research, it might be possible to rephrase the expressions of the questionnaire items with the third-person expressions (e.g., Digital technologies help teachers use digital platforms effectively) to achieve a better methodological correspondence of the phrasing of the instrument to the specifics of the study sample.

3.3. Data Analysis

Having gathered the answers to the questionnaire, the data were processed with the help of the statistical analysis instruments that are frequently applied in the sphere of educational investigation. Both descriptive and inferential statistics were involved in the given analysis to

analyze the responses of the participants and determine the patterns in the data.

The descriptive statistics were initially used to summarize the nature of the obtained data and give an overview of the responses of the participants. These were percentages, frequencies, mean values and standard deviations. Descriptive statistics can be applied to demonstrate the overall trends and rates of the agreement between the participants on the significance of digital education technologies in enhancing the digital cognitive skills of teachers.

Besides the descriptive statistics, inferential statistical analysis was applied in order to analyze the relationships among the study variables and to establish whether there are significant differences in the responses of the participants. The use of statistical analysis is significant in the interpretation of the data and determination of meaningful patterns in accordance with the development of digital competence in teachers (Scherer et al., 2021).

The findings of the statistical analysis give information about the perception of pedagogical professionals about the significance of digital education technologies in improving the digital cognitive competencies of the teachers. The given findings assist in learning more about the factors that affect the development of teacher digital competence and assist in determining possible ways to improve teacher training programs.

In general, the methodological framework used in the current paper will provide an opportunity to explore the views of experts on the importance of digital education technologies to form digital cognitive teacher skills in a systematic manner.

4. RESULTS

This part shows the statistical findings of the analysis of the questionnaire data used with the pedagogical professionals. The purpose of the analysis is to find out the perceived significance of digital education technologies in enhancing the development of digital cognitive competency in teachers. These are the reliability analysis, descriptive statistics, correlation analysis, regression analysis, and hypothesis testing.

4.1. Reliability Analysis

To assess the internal consistency of the measurement scales, the reliability of the questionnaire was tested with the help of Cronbach Alpha coefficient before a main statistical analysis was conducted. Table 1 shows the reliability

coefficients of the key constructs that were involved in this study.

Table 1: Reliability analysis of the study variables.

Variable	Cronbach's Alpha
Digital Education Technologies	0.86
Digital Information Literacy	0.84
Digital Content Creation	0.82
Digital Critical Thinking	0.83
Digital Problem Solving	0.81
Digital Communication and Collaboration	0.85
Overall Digital Cognitive Competencies	0.88

The findings in Table 1 show that the measurement scales applied in the research report satisfactory internal consistency. The Alpha coefficients of the Cronbach vary between 0.81 to 0.88, which is bigger than the suggested alpha coefficient of 0.70 in the field of social science research. These values show that the items used in the questionnaires are always able to measure the constructs that are intended.

Out of the considered dimensions, the general scale of the digital cognitive competencies registered the largest reliability coefficient ($\alpha = 0.88$), which means that the degree of the internal consistency of collaborating items concerning the assessment of the digital competencies of teachers was significant. At the same time, the digital education technologies scale revealed the significant level of reliability ($\beta = 0.86$), which indicates that the statements employed to assess the usage of the digital technologies are statistically consistent.

All in all, the reliability findings prove that the measurement tool employed in the research is statistically sound and can be subjected to further inferential statistics.

4.2. Descriptive Statistics

The summarization of the responses of the participants about the role of digital education technologies in the development of the digital cognitive competencies of teachers was made using the Descriptive statistics. Analysis involved the mean values and standard deviation of the variables.

Table 2: Descriptive statistics of the study variables.

Variable	Mean	Std. Deviation
Digital education technologies	3.84	0.72
Digital information literacy	3.91	0.68
Digital content creation	3.75	0.74
Digital critical thinking	3.82	0.69
Digital problem solving	3.78	0.71
Digital communication and collaboration	3.88	0.66
Overall digital cognitive competencies	3.83	0.70

Table 2 displays the descriptive statistics, which show the general perception of participants about the role of digital education technologies in formation of digital cognitive competencies of teachers. The findings demonstrate that pedagogical specialists expressed comparatively high perceptions in terms of the role of digital technologies on the competencies of teachers.

The average score of digital cognitive competencies was 3.83, which means that there was a high level of consent amongst the experts in terms of the positive contribution of digital technologies towards helping teachers in their professional growth.

Digital information literacy had the highest mean score (3.91) amongst the various dimensions of competency. This observation implies that professionals believe that digital technologies should be considered as more useful to assist teachers in their teaching experience to access, analyze, and use digital information.

On the contrary, the least mean score was obtained in the case of digital content creation (3.75), though this was also a positive perception. This finding can suggest that teachers will need further training to achieve high levels of digital content creation.

The standard deviation values are fairly moderate which implies the moderate degree of consistency of the responses of the participants.

4.3. Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships between digital education technologies and the different dimensions of teachers' digital cognitive competencies.

Table 3: Pearson correlation between digital education technologies and digital cognitive competencies.

Variable	Correlation (r)	Significance (p)
Digital information literacy	0.62	<0.01
Digital content creation	0.58	<0.01
Digital critical thinking	0.60	<0.01
Digital problem solving	0.55	<0.01
Digital communication and collaboration	0.63	<0.01
Overall digital cognitive competencies	0.67	<0.01

The findings of the Pearson correlation analysis that tests the relationships between digital education technologies and digital cognitive competencies of teachers are shown in Table 3. These findings indicate positive and statistically significant relationships between online education technologies and all the dimensions under analysis.

Digital education technologies and digital communication and collaboration ($r = 0.63$, $p < 0.01$) showed the highest correlation, which indicates that digital technologies are strongly correlated with the possibility of teachers to interact and cooperate in digital learning spaces.

Digital information literacy also yielded a strong correlation ($r = 0.62$), which implies that digital technologies play an important role in enhancing the capacity of the teachers to search and appraise digital

information.

Digital critical thinking ($r = 0.60$), digital content creation ($r = 0.58$) and digital problem solving ($r = 0.55$) had moderate positive correlations. Such results imply that the more digital education technologies are integrated, the more digital cognitive competencies among teachers have been achieved.

4.4 Regression Analysis

Regression analysis was conducted to examine the predictive role of digital education technologies in developing teachers' digital cognitive competencies.

Table 4: Regression analysis results.

Independent Variable	Dependent Variable	Beta	t-value	Significance
Digital education technologies	Digital information literacy	0.62	5.84	<0.01
Digital education technologies	Digital content creation	0.58	5.32	<0.01
Digital education technologies	Digital critical thinking	0.60	5.51	<0.01
Digital education technologies	Digital problem solving	0.55	4.97	<0.01
Digital education technologies	Digital communication and collaboration	0.63	6.02	<0.01
Digital education technologies	Overall digital cognitive competencies	0.67	6.45	<0.01

The findings of the regression analysis in Table 4 reveal that the trend of digital cognitive competencies of teachers can be forecasted significantly by digital education technologies.

Digital communication and collaboration were found to have the highest regression effect (digital communication and collaboration, $0.63, p < 0.01$) and thus we can see that digital technologies play a significant role in supporting communication and collaborative practices in digital learning settings.

On the same note, digital information literacy ($\beta = 0.62$) and digital critical thinking ($\beta = 0.60$) had significant effects, indicating that digital technologies are useful in empowering teachers to access, analyze, and critically assess digital information.

Digital content creation ($\beta = 0.58$) and digital

problem solving ($\beta = 0.55$) also have statistically significant effects as shown by regression coefficients. These results validate the fact that online technologies help to evolve the faculty capacity of teachers to produce digital learning resources and respond to learning issues in technology-enhanced learning settings.

All in all, the regression analysis proves that digital education technologies are a meaningful predictor of digital cognitive competencies of teachers.

4.5 Hypothesis Testing

Based on the results of the statistical analyses, the study hypotheses were tested.

Table 5: Hypothesis testing results.

Hypothesis	Result
H1: Digital education technologies significantly contribute to the development of teachers' digital cognitive competencies	Supported
H2: Digital education technologies enhance digital information literacy	Supported
H3: Digital education technologies support digital communication and collaboration	Supported
H4: Digital education technologies enhance digital critical thinking	Supported
H5: Digital education technologies improve digital problem-solving skills	Supported
H6: Digital education technologies support digital content creation	Supported

The hypothesis testing results confirm that all proposed hypotheses are supported. Digital education technologies were found to have statistically significant positive effects on the development of teachers' digital cognitive competencies across all examined dimensions.

These results highlight the important role of digital technologies in supporting teachers' professional development and enhancing their ability to effectively integrate digital tools into teaching and learning practices.

4.5. Discussion

The aim of the current paper was to explore how digital technologies in education, education can develop digital cognitive skills of teachers through the lens of pedagogical professionals. The findings offer valuable information concerning the role of the digital technologies in improving the professional practice and cognitive digital skills of teachers in the modern educational settings. The discussion of the main findings of the research is provided in the section concerning the relation to the previous researches and theoretical insights on the topic of digital education.

4.5.1. Development of teachers' digital cognitive competencies

The results of this research point out that digital education technologies are important to facilitate the acquisition of digital cognitive competencies of teachers. Descriptive statistics indicated that the average scores in the majority of dimensions of competencies were rather high and indicated that pedagogical professionals are aware of the significance of digital technologies to enhance the professional skills of teachers. These findings validate the increased agreement in the literature that digital competence has emerged as a prerequisite to teachers in the contemporary education setting.

Digital education technologies offer educators access to numerous digital materials, communication methods, and other learning environments that help one develop high-level cognition. Digital information analysis, creation of digital learning materials and the use of digital tools in solving instructional issues are increasingly becoming a requirement among the teachers. These skills will be necessary not only to adjust their teaching activities to technological-enhanced learning settings but also to guide the students in acquiring their personal digital competencies. The same conclusions were made by Scherer et al. (2021), who have also noted that digital competence of teachers is a crucial factor related to the success of technology integration in education.

Another finding of the results is that digital information literacy is one of the most developed competencies of teachers. Researchers suppose that digital technologies help teachers to find, assess and apply digital information to their instruction. The given finding can be linked to the former research, which indicated that digital technologies help teachers to access educational materials and assist them in critically analyzing digital information (Hämäläinen et al., 2021).

In addition, the findings demonstrate the

significance of online communication and teamwork in the professional activities of teachers. Digital communication platforms enable the teacher to communicate with the students, work with peers, and engage in professional learning communities. Such collaborative settings enhance knowledge and experience sharing between educators, as well as favoring the ongoing professional growth. As Trust (2018) noted, knowledge sharing with the help of professional learning networks is essential in making teachers acquire digital skills.

4.5.2. Role of digital education technologies in teaching practices

The other significant research result of the paper has to do with the perceived effectiveness of the various types of digital education technologies. The findings indicated that the learning management systems and collaborative digital tools were some of the most significant technologies that had an impact on facilitating the professional activities of teachers. These technologies offer structured platforms of handling learning activities, disseminating educational resources in addition to enabling teacher-learner communication.

Learning management systems especially have become such a requisite in digital learning. They enable educators to plan course resources, test the assignments, track the students progress, and communicate with the students in online courses. The resultant mean score of learning management systems in the study is high, which indicates that the experts are of the view that the learning management systems are core elements of digital teaching. Past studies have also pointed LMSs as some of the critical technologies to assist in the development of digital competence among teachers and improve the organization of digital learning environments (Moreira et al., 2023).

Cooperative digital tools are also useful in facilitating interactive learning. Through these tools, the teacher is able to involve the students in collaborative learning, in group discussions, and in peer learning. It is known that collaborative learning environments facilitate the active learning and student engagement, which are fundamental elements of successful digital education (Means et al., 2013).

The results, however, also show that digital assessment tools were rated rather poorly in comparison to other technologies. Digital assessments can be effective in evaluating the performance of students as well as delivering feedback, but still, teachers might experience some

difficulties in the process of creating and carrying out digital assessments. Digital assessment involves the presence of certain skills connected with the production of web-based exams, analysis of learning statistics, and delivery of feedback to learners in a personalized format. The earlier research has also indicated that further practice in the digital assessment should be trained so that the teachers could effectively apply these technologies (Siddiq et al., 2016).

4.5.3. Factors influencing digital competence development

Digital competencies development of teachers is affected by numerous individual and situation-related factors. The beliefs and attitudes of teachers towards digital technologies are one of the most significant aspects that have been determined in earlier studies. Those teachers who see the digital technologies as the useful educational resources are more inclined to use them in their instruction and participate in the professional development activities connected with the digital education.

Ertmer and Ottenbreit-Leftwich (2010) maintained that the conviction that teachers have about technology is very important in dictating the success of integrating digital tools in teaching activities. The attitudes of teachers to technology tend to have a positive impact on the readiness to experiment with new digital tools and use them in their teaching plans.

Technological self-efficacy is also another significant variable that affects digital competence development. The more confident teachers are in their skills of using digital technologies, the more likely they will resort to new teaching strategies and use digital technologies in the classroom. According to a research by Hatlevik et al. (2015) the relationship between technological self-efficacy and digital competence is observed, stating that the higher the pleasure in digital skills is, the higher the digital competencies are expressed by the teachers.

The institutional support is also an important factor that facilitates the development of digital competence among teachers. The learning institutions should offer sufficient technological facilities, access to online resources, and career development opportunities. Unless there is an adequate institutional backlash, educators might find it challenging to embrace digital technologies in their teaching methods. Althubyani (2024) highlighted that among the institutional factors are training programs, technological infrastructure, and administrative provision; these play significant roles

in determining the level of digital competence in teachers.

4.5.4 Implications for teacher professional development

These findings show the relevance of the continuous professional development programs in the development of the digital competence of teachers. With the advancement of digital technologies, educators need to undergo the lifelong learning process to possess a chance to be effective teachers working in the digital learning environment.

The professional development programs must also be based on pedagogical incorporation of digital technologies in addition to technical skills. Teachers should receive training that can enable them to know how technology can be utilized to promote student learning, collaborative learning and encourage innovative teaching practices. Lawless and Pellegrino (2007) pointed out that good technology training programs must integrate technical training with pedagogical uses in order to have meaningful technology integration.

Moreover, the elements of teacher training programs should promote the collaborative learning and sharing of knowledge amongst teachers. Teacher networks online and professional learning communities are some of the avenues that offer important experiences to teachers to share experiences, challenges and learn among themselves. This type of collaboration facilitates building the digital skills of the teachers and the application of new teaching methods (Johannesen et al., 2024).

The teacher education institutes too can play a key role in training the new teachers to work in the digital teaching world. One of the ways in which digital competence frameworks can be integrated in teacher education curriculum is to make sure that new teachers are equipped with the necessary skills needed to effectively utilise the digital technologies in their teaching environments. As Tondeur et al. (2017) pointed out, one of the aspects that teacher education programs should offer is systematic training in the integration of technology so that teachers could be equipped to meet the challenges of digital education.

4.5.5 Contribution of the study

The current study is a contribution to the existing body of literature on the digital competence of teachers as it gives an idea of the role of digital education technologies in shaping digital cognitive competencies of teachers. The research conducted through the lens of the views of pedagogical experts

reveals useful information concerning the competencies that teachers should have to fully incorporate digital technologies in their working practices.

The results also emphasize the need of integrating technology means with the pedagogical approaches to the full extent of the educational value of the digital technologies. Digital education technologies cannot change the teaching practices on their own; teachers also need to have the cognitive and pedagogical skills that will allow them to utilize such technologies.

On balance, the findings indicate that the digital education technologies can be used to promote digital cognitive competencies of teachers in case of the proper professional development programs, institutional support, and positive attitudes of teachers to the technology integration.

The results of this research could be used in the development of more effective teacher training programs by educational organizations and policy makers to enhance the level of digital competency of teachers and facilitate successful introduction of digital technologies in the education process.

5. CONCLUSION

The fast increase of the digital technologies has had a great impact on the modern educational settings and has posed new requirements to the professional qualification of teachers. In this regard, digital competence has emerged as a necessary requirement of an educator who is supposed to be able to incorporate the use of digital technologies into the teaching process. The current research was designed with the purpose of investigating how digital education technologies influence the establishment of digital cognitive competencies of teachers in accordance with the views of pedagogical experts.

The research results show that the digital education technology is significant to improve the digital cognitive competencies of teachers. Pedagogical specialists tended to believe that digital technologies have a vast contribution to the development of some of the main competencies such as digital information literacy, digital communication and collaboration, digital critical thinking, digital problem solving, and digital content creation. Such competencies are able to help teachers

move freely in the digital learning environment and modify their teaching approaches to meet the requirements of contemporary digital learning.

The findings also emphasize the value of digital education technologies like learning management systems, online learning platforms, collaborative digital tools, as well as multimedia learning resources. These technologies offer the teachers a chance to access education materials, interact with students, create interactive learning activities, and join professional learning communities. Therefore, the combination of these technologies will help in enhancing the practices of teaching and also maintaining the professional growth of the teachers.

Nevertheless, the research also indicates that to achieve efficient incorporation of digital technologies into teaching, it is not only about the availability of technology tools. The educators should have the requisite cognitive and pedagogical skills that can make them utilize digital technologies in a meaningful manner. Professional development programs in this respect are very important in helping teachers to develop in digital competence. Teachers can be effectively trained with the help of the training programs paying attention to both technological and pedagogical integration of technology to successfully introduce the digital teaching technologies.

Moreover, the digital competence of teachers should be encouraged with the help of institutional support. Schools must have sufficient technological facilities, access to online materials, and nonstop education opportunities. It is possible to foster the growth of digital competencies by creating positive conditions in which teachers can experiment with digital technologies and cooperate with their peers.

In general, the findings of this work outline that digital education technologies can greatly enhance cognitive capabilities and professional practices of the teacher. Nevertheless, this objective can be attained by means of a truly multipronged approach which consists of using technologies, professional development courses, and supportive institutional policies. The future research can also investigate the factors that have an impact on the development of digital competence of teachers and can be used to study the effectiveness of particular training programs to help teachers improve their digital cognitive skills.

Appendix A

Instrument items and components used in the questionnaire.

Component	Sub-component	Item
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Digital Education Technologies	Digital resources	DET1: I use digital repositories and online educational resources to support my teaching activities.
		DET2: I use digital platforms to access and organize educational materials for my lessons.
	Learning management systems	DET3: I use learning management systems to manage course content and learning activities.
		DET4: I use digital platforms to distribute course materials and assignments to students.
	Digital communication tools	DET5: I use digital communication tools to interact and communicate with students.
		DET6: I use online collaboration tools to facilitate communication among students.
	Digital assessment tools	DET7: I use digital assessment tools to evaluate students' learning progress.
		DET8: I use digital technologies to provide feedback and monitor students' performance.
Teachers' Digital Cognitive Competencies	Digital information literacy	DCC1: I can search for and identify relevant digital information for teaching purposes.
		DCC2: I critically evaluate digital information before using it in my teaching practice.
	Digital content creation	DCC3: I create digital learning materials such as presentations, videos, or multimedia resources.
		DCC4: I adapt or modify digital learning materials according to students' needs.
	Digital critical thinking	DCC5: I analyze digital information and select appropriate digital tools for teaching activities.
		DCC6: I evaluate the effectiveness of digital technologies used in teaching.
	Digital problem solving	DCC7: I solve instructional problems using digital technologies.
		DCC8: I can handle technical difficulties that arise during digital teaching activities.
	Digital communication & collaboration	DCC9: I collaborate with colleagues using digital technologies for teaching purposes.
		DCC10: I encourage students to participate in collaborative digital learning activities.

Professional Digital Development	Online professional learning	PD1: I participate in online training courses to improve my digital teaching skills.
		PD2: I use digital professional networks and communities to exchange educational experiences.

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