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Developing future teachers' digital competence via massive open online courses (MOOCs)

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Abstract

This empirical study was conducted to develop third-year students' digital competence at Abai Kazakh National Pedagogical University, Kazakhstan and test the effectiveness of massive open online courses (MOOCs) to increase digital competence. Future teachers' digital competence was regarded as a combination of knowledge, skills, abilities, strategies acquired in their learning experience and improvement in integrated activities using digital and network technologies to solve professional issues. The relevance of developing future teachers' digital competence was associated with their insufficient knowledge and skills, which was reflected during the diagnostic stage analysis in using digital and network technologies in the educational process. Many approaches and tools have been adopted to develop future teachers' digital competence and one of them is MOOCs. In this study, mixed methods were used, for example, theoretical analysis of pertinent literature, generalization, systematization, specification of conclusions and statistical analysis of the pedagogical experiment. The primary data were collected through the researchers' pre- and post-experiment questionnaires. The findings of this study *c*onfirm that MOOCs as a distance learning technology have positively affected all participants and effectively improved future teachers' digital competence depending on four components (*motivational, technological, cognitive, and ethical*) and the indicators of future teachers' digital competence presented.

Keywords: *Digital technologies, digital skills, digital competence, distance learning, Massive Open Online Courses (MOOCs).*

Introduction

Today's students are surrounded by digital technologies and networks that have become highly prevalent and indispensable for imparting education. Researchers have actively investigated students' relationship with technology (Bennet et al., 2008; Lea & Jones, 2011; Prensky, 2001) and their lack of digital skills in the digital learning environment (Prescott, 2018). Prensky (2001) introduced the

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terms “digital natives” and “digital immigrants” and discussed the differences between them. He further claimed that “digital learners” are accustomed to acquiring information very quickly, and they like to process or multitask in parallel and evaluate information in fundamentally distinct ways than their ancestors. These disparities are substantially more profound and pervasive than most educators recognize. A digital immigrant is an individual who was not born in the digital age but was attracted by and embraced most features of modern technology at some time in his or her life. Today's learners or digital natives are defined as the natural speakers of digital devices and the Internet. Those educators who adopted technology later in their lives and interact in an “obsolete language” are trying to teach learners who interact in an altogether new and different language (Prensky, 2001). The term “digital immigrant educator” refers to an educator who does not acquire sufficient digital knowledge or skills, but there is a contradictory opinion among researchers on the concept of digital natives. For instance, researchers (Gallardo-Echenique et al., 2015; Kennedy & Fox, 2013; Prescott, 2018; Voogt et al., 2013) have posited the idea that even though today’s students are highly engaged in the digital environment, they do not possess the requisite digital skills for learning. They rather use digital technologies primarily for personal aims, such as entertainment and communication and are unable to attend conventional academic studies (Gurung & Rutledge, 2014; Lea & Jones, 2011).

The assumption that current students are technologically advanced as they were born into a digital age may limit their progress toward being digitally competent (Prescott, 2018). Some researchers have also noted the idea that most students studying for careers beyond computer science, electronics, and information technologies have enough computer knowledge, skills and abilities, which may even be incorrect (Li & Ranieri, 2010; van Deursen, 2010). A similar condition is faced and the diagnostic phase’s results verify the research findings in the present investigation. The pre-survey analysis justifies that future teacher do not attain enough digital skills for effective education. Although they are knowledgeable or familiar with ICT, new teachers may not be able to incorporate technologies in their future profession and exhibit enough competency for didactic purposes (Ciriza-Mendívil et al., 2022).

The digitalization of education and the urgent pandemic has transformed teachers’ current role, brought new standards and expectations for new competencies in their professional activities and requirements for ongoing professional growth. Teachers are beyond knowledge carriers but they are instructors, giving guidance to digital learning environments. And these processes have also brought new requirements for learners (Dube et al., 2022; From, 2017; Tachie, & Kariyana, 2022). Especially,

the pandemic accelerated the role of ICT as an educational tool (Tadeu, 2019; Tarman, 2020) and interaction among educators and learners to comprehensively build knowledge together (Erbilgin & Şahin, 2021; Kalimullina, 2021). Thus, teachers and students should attain knowledge, skills and abilities to work with digital technologies, organize their self-study, search or employ pertinent information and adopt teamwork and collaborative skills. The digital age demands that users develop a new thinking style and the ability to adapt to new literacies commanded by modern technologies (Coiro et al., 2008). It applies to both students and teachers, and the formation of teachers' digital skills, depending on the needs of the modern world, will inevitably rely on a highly digitally expert teacher. In this respect, "multifunctional, over subject and multidimensional key competencies must be developed" within any training areas' frame (Galkina, 2017). Procuring these kinds of competencies definitely will help to solve problems in an individual's professional and social lives and digital competence is one of them. Per all the above issues and research findings, the researchers consider developing future teachers' digital competence a very topical issue. Since students live with the rapid advancement of technology, only digitally proficient teachers will be able to adapt to novel changes, self-develop and provide a high-quality education by taking advantage of all the opportunities that technology provides. That is why, it is critical issue to investigate effective methods of developing future teachers' digital competence. The research specifies the concept of prospective teachers' digital competence, determines the components, measuring levels and criteria. Moreover, the effectiveness of the MOOC will be tested and the results of the pedagogical experiment will be summarized. Lastly, the research formulates the theory of developing future teachers' digital competence. Solving these problems contributes to research by addressing prospective teachers' digital competence from both theoretical and practical perspectives, as well as expanding knowledge of distance learning technologies such as MOOCs.

Research Questions

RQ: Whether the given MOOC treatment can produce significant differences in the four structural components (motivation, technology, cognitive and ethical) digital competence of prospective teachers in the experimental pretest and posttest groups?

Hypothesis

Ha_1: The MOOC treatment given can produce significant differences in the four structural components (motivation, technology, cognitive and ethical) digital competence of prospective teachers in the pretest and posttest experimental groups.

Ha$_2$: The MOOC treatment given can produce significant differences in the four structural components (motivation, technology, cognitive and ethical) digital competence of prospective teachers in the pretest and posttest control groups.

Review of Literature

Gilster (1997) defined the digital literacy concept as "the ability to understand and use information in multiple formats from a wide variety of sources when it is presented via computers". He emphasized teaching and learning by articulating "how to assimilate the information, evaluate it then reintegrate it" (Pool, 1997). Thus, digital literacy requires several sophisticated competencies, including cognitive, social or emotional ones, which learners must possess to utilize digital technology properly, save for simple abilities involving software or digital tools use (Gilster, 1997). "Digital literacy involves interacting with information, interacting with information is about assessing its truth, credibility, reliability and so on" (Lankshear & Knobel, 2015).

The relevance of information is accentuated in European Union's (EU) definition. Digital competence includes using information technology critically for the job, recreation and communication. The description is "to retrieve, assess, store, produce, present and exchange information and to communicate and participate in collaborative networks via the Internet*."* (European Parliament & the Council, 2006). Several studies have stressed the vitality of information and stated it as the ability to critically search (Brečko et al., 2014) the responsibility to analyze, choose, critically evaluate (Calvani et al., 2008; Tsankov & Damyanov, 2017) and manage (Hernandez et al., 2015) information acquired by a computer. Many digital competence definitions exist, including "the set of knowledge, skills, attitudes, abilities, strategies and awareness that are required when using ICT [information and communication technologies] and digital media to perform tasks; solve problems; communicate; manage information; collaborate; create and share content; and build knowledge effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically, reflectively for work, leisure, participation, learning and socializing." (Ferrari, 2012)

The digital competence definitions have developed and adapted to the advancement of digital technologies and progressed with the latest innovations. In this regard, outdated applications formerly comprising digital proficiency will perish as technology advances, allowing new expectations to bloom (Maderick, 2013). People must acquire new competencies with the ongoing development of novel technologies.

Many studies have explored the teachers' digital competence concept. For example, Norwegian researcher Krumsvik (2011) delineates it as: "the teacher's proficiency in using ICT in a professional context with good pedagogic-didactic judgment and his or her awareness of its implications for learning strategies and the digital building of pupils". From (2017) stresses the *pedagogical digital competence* and in his perspective, "the concept of pedagogical digital competence refers to the ability to consistently apply the attitudes, knowledge and skills required to plan and conduct and to evaluate, revise on an ongoing basis, ICT-supported teaching, based on theory, current research and proven experience with a view to supporting students' learning in the best possible way". It is similar to the previous definition. However, a teacher's digital competence does not only include the ability to use ICT efficiently. Still, it involves the digital technologies' complete mastery to address professional issues. Nevertheless, ICT and digital technologies have expedited digital skills by locating, conveying, using, and storing information that teachers are to improve (Masrur, 2021; Ozden, 2018). Teachers differ from other technology consumers as they utilize technologies for didactic purposes and instruct students on specific learning objectives.

Then, a group of researchers specifies the components of digital competence. For instance, Gapski (2007) posed digital literacy in two directions, including "instrumental-technological" and "normative media-educational" linking to its use or function and pedagogical goals. They consisted of three competencies: 1) interpreting, 2) choosing and 3) articulating messages. Tornero (2004) indicated "digital literacy merges capabilities: purely technical aspects, intellectual competencies and competencies related to responsible citizenship. They all allow individuals to develop themselves completely in the information society". An exceedingly similar conclusion was presented by other researchers (Calvani et al., 2008). They noted that digital competence was the integration of *technological, cognitive,* and *ethical* components. The technological one included the ability to investigate digital contexts flexibly. Yet, the cognitive one was related to the skills and abilities to assess digital content and data, their relevance or reliability, critically. The ethical component involved the ability to communicate responsibly using technology, covering protecting personal data, respecting others and understanding copyright rules. Nonetheless, these components may not be adequate to be a digitally competent person. Simultaneously, researchers concentrated on the individual's motivation for using technologies in their daily and professional activities (Soldatova & Rasskazova, 2014). They disclosed that improvement in one's self-management skills and an

understanding of digital citizenship. This opinion seems reasonable and it is exceedingly critical to urge an individual to use digital technologies efficiently in society.

Digital competence as teachers' professional capability was reflected in the Digital Competence Framework for Educators in Europe (Redecker & Punie, 2017). This framework provides a complete set of competencies educators need to incorporate into their professional practice to help students achieve the curriculum objectives. The Educators' Digital Competence structure mirrors all aspects of their professional activity and specifies three core competencies in six areas. The first area involves teachers' knowledge of using digital devices to enhance instruction, establish professional interaction with learners, parents and colleagues and develop reflective practice and professional growth in a collaborative environment. The pedagogic competence area discloses teachers' ability and responsibility to handle digital resources comprehensively and adapt them to their teaching goals, learning and teaching strategies. Also, it encompasses teachers' ability to use digital devices in the design and plan teaching process, assessment strategies and methods for organizing and promoting students' independent or group learning. The last competence area concentrates on their ability or responsibility in expediting learners' competencies to deal with information, responsible use, digital content creation, interaction and problem-solving.

This research's initial objective is to develop a prospective teacher's digital competence. Therefore, a need to define the concept includes analyzing the literature. A prospective teacher's digital competence includes: "the ability, knowledge and skills acquired in the learning experience through the integrated activities to solve professional issues using digital technologies responsibly".

Competence development is described as "a multifactorial, hierarchical and time-consuming process to improve some skills and acquire new ones, increase personal qualities, gain confidence and the ability to act independently in new situations" (Shubkina, 2016). Therefore, DigCompEdu specifies the six levels to assess teachers' digital competence. The research depends on this framework to describe the components and evaluate the prospective teachers' digital competence. A1 and A2 (Awareness/Exploration) levels include learners' understanding and exploring the digital technologies' potential and application in pedagogical and professional activities through the collaborative exchange of experiences. B1 and B2 (Integration/Expertise) levels comprise the competencies to integrate technologies confidently, critically and creatively into professional activities' several aspects in a collaborative environment and comprehend the digital strategies' pros and cons. C1 and C2 (Leadership/Innovation) levels underline the competencies in using digital

technologies for specific goals, looking for further development, evaluate the digital pedagogical experiences' advantages and disadvantages. These levels disclose digital competence's motivational, cognitive and reflexive components. Other research (Calvani et al., 2008; Gapski, 2007; Soldatova & Rasskazova, 2014; Tornero, 2004) accentuates digital competence's ethical evaluation is essential in keeping one and others safe in a digital world. Researchers consider the DigCompEdu framework's (Redecker & Punie, 2017) descriptions/dimensions in defining the digital competence' components. It agrees with Calvani et al.'s (2008) conceptual framework, emphasizing the effective use of technology, digital content or resources and responsible communication. Scientists added the extra *motivational component* to Calvani et al.'s digital competence (*technological, cognitive and ethical*) depending on previous studies. All these four components are exceedingly essential and should be mutually developed. Then, the researchers identified the levels for developing a prospective teacher's digital competence. They simplified the levels and specified "low," "medium," or "high" levels of prospective teachers' digital competence based on the DigCompEdu framework. Each component's description and digital competence level are in Tables 1 and 2.

Table 1

The Prospective Teachers' Digital Competence Structure

Motivational	A prospective teacher's activity and need to use digital technologies; acquire the necessary knowledge and skills to use digital technologies
Technological	A prospective teacher's ability, knowledge and skills to solve technical issues, and conceptually understand digital technologies
Cognitive	A prospective teacher's the knowledge, ability, skills to work with digital content and network resources, databases critically, creatively; and independently model the educational process using innovative digital technologies, the ability to consciously and individually exercise and regulate the control of one's level and development, personal achievements
Ethical	Protect one's and others' intellectual rights, personal opinions, views, communication, digital educational environment and protect the confidentiality, personal data

All the components of digital competence are mutually interrelated. However, focusing on the motivational component is the most crucial. To form students' positive attitudes toward technologies, educators must demonstrate effective use of the model in the learning process. Students should be taught how to use technology as creators instead of consumers, to display technological proficiency by identifying and using all possibilities for developing and disseminating knowledge. The cognitive component involves the knowledge or skills to evaluate digital content and the ability to identify the pertinence and reliability of the information. Educators should teach students to compare and contrast digital data to make accurate decisions to develop cognitive competence. The last component of digital competence includes communicating

responsibly with others while using technology. It covers teaching to recognize the value of respect and accountability, secure personal information, respect people's viewpoints and follow copyright laws.

Table 2

The Prospective Teachers' Digital Competence Levels

Levels/structure	Low	Medium	High
Motivational	Lack of knowledge and skills to communicate and work with information on the Internet, network resources and digital technologies for professional activity	Insufficient need for using digital devices, ICT and networks in professional areas and the need to acquire the necessary knowledge or skills	The presence of motivation to achieve and master digital technologies consciously, ICT, or networks on a daily and professional basis. The desire to constantly improve professional level using digital technologies
Technological	Lack of knowledge and skills to solve typical technological difficulties and understand technologies conceptually	Insufficient knowledge and skills, the need to acquire to recognize interfaces, solve typical technological difficulties and conceptually understand them	Knowledge, skills, abilities to face technologies flexibly, determining the benefits and drawbacks of technologies; knowledge, skills, abilities to solve complex technological difficulties and understand them conceptually
Cognitive	Has the necessary knowledge, ability and skills to select, create and modify digital content, exchange it with others; the ability to organize students work in digital spaces and learn in a self or collaborative environment	Has the skills to select information critically; creatively create and change digital content, share them; the ability to manage educational content, creatively use knowledge and skills to organize students' self-study in digital spaces, learn in a collaborative environment	Freely selects the necessary information from open educational spaces, can create and modify digital content, can organize and manage, share content in a community with others; can organize students' self-study/ group learning in digital space, learn in a collaborative environment; confident, creative, and critically use knowledge and skills to work with students using digital technologies, as well as develop ways to solve digital problems
Ethical	Lack of knowledge and skills to communicate and work with information on the Internet; lack of critical assessment and protection of one's digital space, and lack of the significance of one's own and others' intellectual rights	The presence of insufficient knowledge and skills to protect one's own and others' intellectual rights, personal opinions, views, personal communication on the Internet, digital educational space, understanding the competent use of information from the Internet, acceptance, and understanding of critical assessments in exchange of information, know about the protection of the confidentiality and personal data	Knows the ways to protect one's and others' intellectual rights, digital educational space, can verify the correctness of the information, communication, and always has a critical opinion, knows the ways to protect the privacy and personal data.

Massive open online courses (MOOCs)

By defining the prospective teachers' digital competence concept, its levels and criteria/indicators, researchers deliberate the methods for its development. A review of international research has

revealed that MOOCs develop citizens' digital practice (McAuley et al., 2010). Some empirical research considers MOOCs as a tool for developing teachers' digital competence (Bartoletti 2016; Chan, 2018; Koukis & Jimoyiannis, 2017; Rivera & Ramírez, 2015; Wambugu 2018). In addition, several research emphasize MOOCs as a tool for professional development (Bonafini, 2018; Gushina & Mikheeva, 2017; Kopytova, 2015; Lebedeva, 2015; Mozhayeva, 2015; Zakharova & Tanasenko, 2019). MOOCs are the emerging developments in distance education (Lewin, 2013). MOOCs have changed from the open educational resources (OER)'s concept and open courseware (OCW). OER is described as: "digitized materials offered freely and openly for educators, students and self-learners to use and reuse for teaching, learning and research" (Atiaja & Proenza, 2016). MOOCs are specified as: "*online courses designed for large numbers of participants, that can be accessed by anyone anywhere as long as they have an internet connection, are open to everyone without entry, qualifications, offer a full/complete course experience online for free*" (Ischinger, 2007). One of the ICT revolution's "dividends" includes the ability to scale learning and make it available everywhere, at any time (Moore & Diehl, 2019).

According to MOOCs' pedagogy, literature presents the broader two types: xMOOCs and cMOOCs (Siemens, 2004). xMOOCs have been developed from behaviorism and depend on information transmission. They focus on the course materials or instructors (Chen, 2013). In the present study, researchers have focused on cMOOCs. Siemens and Downes (2008) reported that technology had a remarkable influence on society and posed substantial changes in teaching and learning; the authors suggested connectivism as one of the alternative learning theories. Precisely, the cMOOCs (c-connectivist MOOCs) are acknowledged as a tool to enhance digital competence in the learning process. The attention is on students and knowledge in cMOOCs. cMOOCs' structure depends on connectivism principles as "autonomy, diversity, openness and interactivity and the activities as aggregation, remixing, repurposing and feeding forward the materials and studying" (Rodriguez, 2012). The connectivism theory confirms the possibilities of efficient learning in exchanging information among people and building communication using technology. MOOCs allow participants to reinforce their skills due to their massive scale, openness and flexibility distinguishing them from the traditional online course's paradigm. They may be loaded and are expected to be in an uncertain, changeable environment (McAuley et al., 2010). cMOOCs networks are where information is generated, shared and enhanced by participants. Researchers believe that building knowledge through participation and interaction in MOOCs fosters the development of many competencies including

digital, information, cultural and creative and technical skills. Given the rapid information change, the authors deduce that if there is a need to rely on the correct theoretical foundation, the funds should be allocated to guiding, educating and interacting in the educational process instead of creating content (McAuley et al., 2010).

Furthermore, researchers (Chan, 2018; Hernandez et al., 2015; Kop, 2011; Koukis & Jimoyiannis, 2017; Rivera & Ramírez, 2015; Wambugu, 2018) justify that developing and participating in MOOCs enable teachers to utilize open educational resources in distance learning environments, collectively create content, exchange experiences and foster both their didactic skills and digital competencies. In this respect, connectivism can be a pedagogical tool to improve learning in MOOCs. It means that prospective teachers can interact through materials, communicate via networks and materials, create an online community, promote learning and share their experiences. Connectivism, as a method, boosts a prospective teacher's digital competence, demanding MOOC participation, digital competence and developing skills in online learning and responsibility in an open educational space by self-managing, studying, sharing and contributing to others. Furthermore, researchers can test the course's effectiveness and possibilities in the designed experiment. Next, the research sets several objectives such as defining the theoretical basis for formation of future teachers' digital competencies through MOOCs, defining the concept of future teachers' digital competence, the level and criteria for measuring the digital competence and developing the method and testing its effectiveness.

This study begins with the hypothesis that MOOC is critical for building digital competence (McAuley et al., 2010). Therefore, this research aims to check the formulated hypothesis regarding the prospective teachers' digital competence formation, test the MOOC's effectiveness and possibilities in building *motivational, technological, cognitive,* and *ethical* components of digital competence.

Methods

Design

An experimental design called the Pre-Posttest Control Group is used. Before and after measurements are taken in a pre- and post-treatment experiment. In this design, there are two groups and only one of them receives the treatment. The other group's results are gathered after the treatment has been completed. In the same amount of time, members of the control group do not receive any treatment, but they are subjected to all of the same examinations. After that, statistical analysis can be used to determine whether or not the intervention had a meaningful

impact. The design allows you to see how a treatment affects a group of people. In this study, two groups are chosen at random and then given a pre-test to determine the initial state of the experimental and control groups to see if they differ. When comparing the experimental group's results to those of the control group, good treatment outcomes are defined as a difference between the pretest and posttest that is statistically significant (without treatment).

Sample

According to the design of the experiment, students were purposefully selected from both pedagogical specialties with the same knowledge background and had to take the course. The control group received a set of practical assignments from the MOOC to implement individually and the experimental students signed up for the MOOC, totaling 147 students. The experiment included third-year students at the Kazakh national pedagogical university named after Abai, majoring in "Pedagogy and Psychology," "Pedagogy and Methodology of Primary Education" and occurred between 2020 and 2021. The “Introduction to MOOC” course was designed for six weeks (3 credits) and the researchers used open educational resources and developed explanatory brief video material sets, presentations, texts, quizzes and discussion forum topics depending on the MOOC format. Discussion forums were structured on the course platform (Moodle) and network discussions were organized in Google groups and Twitter. The control (87 students) and experimental groups (60 students) were systematized.

Instrument

A questionnaire with twenty different items served as the research tool for this investigation. The items were arranged as follows: 5 items pertaining to motivation, 7 items pertaining to technology, 5 items pertaining to cognition and 3 items pertaining to ethics. Check out table 3 to see how the items are distributed as well as the statements that are included in the items.

Table 3.
Research Instrument

No	The Prospective Teachers' Digital Competence Levels		Statement
1	Motivational Competence	1.	The role of digital and network technology is very important, and they offer teachers huge opportunities to improve their professional development
		2.	Digital technologies and collaborative networks are effective tools to exchange pedagogical experiences among colleagues
		3.	Digital and network technologies offer the possibility of exchanging materials quickly
		4.	The effective use of digital and network technologies improves students' motivation, digital knowledge and skills through digital content
		5.	Digital and network technologies enable to create and organize student-centered, individual, group and collaborative learning activities
2	Technological Competence	6.	I can effectively use digital devices and ICTs for the educational process
		7.	I can select and install the appropriate software for creating digital resources
		8.	I can manage my digital/internet /network / resources
		9.	I can share digital/internet /network / resources
		10.	I can create and manage individual/ group/collaborative digital learning environment
		11.	I can provide feedback in individual/ group learning digital environment
		12.	I can understand the concept of "cloud" and use it effectively
3	Cognitive Competence	13.	I can critically evaluate and use digital resources
		14.	I can find and select, change the internet and network resources
		15.	I can create and change, use texts, types of assessment quizzes
		16.	I can create and use, change audio and video files
		17.	I can create and use, change various types of presentations
4	Ethical Competence	18.	I can effectively protect my digital learning environment and digital resources
		19.	I understand copyright rules and responsively communicate with others
		20.	I can effectively cite to copyrighted resources

In order to determine whether or not the questionnaire was valid and reliable, pilot testing was conducted using Spearman Rank correlation and Cronbach Alpha. Because the data were ordinal and the statistical test was a non-parametric one, both formulas were employed. A validity test is a way of determining the degree to which a question's validity in relation to the entire item can be quantified. A Spearman rank correlation is used because the scale used in this test is ordinal. If the Spearman rank correlation value is greater than r table, then the question item is valid (Ghozali, 2018). Tests for reliability are used to determine how consistent respondents' answers are. The Cronbach alpha value is used in the test. If the Cronbach alpha value is greater than 0.7, the question item is considered reliable by the test criteria (Ghozali, 2018). Please refer to table 4 for the full analysis.

Table 4.
Validity and Reliability Test

No	Item	Spearman Rank Correlation	Cronbach α
1	MC1	0,682	0,790
2	MC2	0,770	
3	MC3	0,667	
4	MC4	0,748	
5	MC5	0,814	
6	TC1	0,708	0,769
7	TC2	0,597	
8	TC3	0,614	
9	TC4	0,679	
10	TC5	0,648	
11	TC6	0,650	
12	TC7	0,599	
13	CC1	0,872	0,746
14	CC2	0,715	
15	CC3	0,590	
16	CC4	0,697	
17	CC5	0,608	
18	EC1	0,842	0,747
19	EC2	0,796	
20	EC3	0,814	

The results of the validity test above use (n) 30 respondents so that the value of r table = 0.349 (df = n-2 = 30-2 = 28 and = 0.05). Furthermore, a comparison is made between the value of the Spearman rank correlation (r count) with the value of r table. It can be seen that all the calculated r values are greater than r tables, so it can be said that all statement items are valid. In addition, the results of the reliability test were tested by comparing the calculated Cronbach alpha value with the critical Cronbach alpha value (0.7). We can conclude that all Cronbach alpha values have been above 0.7 so it can be said that all items are reliable.

Research procedure

Students have their pedagogical experience in their third year and the experiment is organized in advance to be conducted at this time to assist students with their pedagogical practice. Thus, it helps with their pedagogical practice. Students learn how to build communication with their school groups, organize educational events, prepare digital resources and use a variety of software for

didactic purposes during their pedagogical practice. The experiment was conducted as required and most students were eager to take the online course.

The research aims to develop future teachers' digital competence components. The purpose of the *motivational component* is to form a conscious and positive attitude toward doing professional activities. A digital learning environment (the MOOC) was designed to achieve this. Students can study at their own pace and are expected to master the materials autonomously based on the facilitator's instructions. The learning process was organized by considering the four essential activities of connectivism as including *aggregation*, *remixing*, *repurposing* and distributing the material in *feed- forward* (Siemens & Downes, 2008). The accessibility of MOOCs at any time, the flexibility of multimedia materials to master at their own pace and the possibility of discussing professional topics with their peers all contribute to forming positive motivation. Although the course is asynchronous, the facilitator's support of discussions in the experimental group and the constant instructions and feedback help students interact closely and perform tasks systematically. Commonly, students use social media more in their everyday lives than in professional areas and the model of using social networks for professional topic discussions will fit best for using technologies for educational purposes. The *technological component* aims to raise students' awareness and conceptual understanding of using technologies to address educational challenges by establishing goals and objectives. After mastering the content of the course's knowledge, students create Google group or Twitter discussions and practice sending invitations, registering participants and presenting a new topic for discussions. The next assignment involves students choosing and downloading one of the free internet software such as Free Cam, Cam Studio or Screen-cast-o-Matic and preparing material for didactic purposes. For instance, students practice preparing very brief video materials. It may include a video presentation or other videos and participants post them on social media discussions on the given professional topic. Each week, students do specific assignments based on the content and have video instructions for creating video materials and participating in network discussions.

Participants engage in a series of activities to develop the cognitive component and notably, all aspects of digital competence are developed mutually. Students gain access to the course information through aggregation, where they can review the course structure and watch instructional or explanatory videos. Then, they do a series of quizzes to clarify the content. In turn, they are motivated by responding to each other's opinions or asking questions in discussions

under the guidance of the course facilitator. In repurposing and feed-forward stage, they are tasked with searching for materials for discussion forum topics related to their professional sphere and processing information to understand if the content is appropriate to post. Then they share it with others in social media discussions by citing the retrieved sources and expressing their agreement or disagreement with the posted material.

Thus, the complex development of digital competence is carried out through the process of studying the theoretical materials and implementing practical tasks, as well as the exchange of professional knowledge and experience that are based on methodical, professional assignments integrated with networks and digital technologies. By attending the course, students develop their digital competencies, theoretical knowledge and learn how to develop MOOCs. Its successful implementation relied on the pedagogical, didactic and methodological prospects of organizing the learning process and a digital learning environment formation.

The MOOC's brief content on developing digital competence is as follows:

Week 1- Digitalization of Education: Novel trends in education. The Digital Competence concept: Digital Competence Framework for Educators (DigCompEdu).

Week 2- An MOOC overview as a distance learning technology. The MOOC phenomenon.

Week 3 - MOOCs pedagogy. MOOC's types: xMOOC and cMOOC.

Week 4-5 Designing MOOCs. Texts and video lectures' linguistic style. Video recording and editing. Discussion forums. Network collaboration. Quizzes. Monitoring and evaluation.

Week 6 - Digital citizenship. Copyright rules.

The students implemented the following practical assignments and shared them in each week's discussion forums per the suggested course topics.

- Identify false/ reliable information
- Create, share texts/blogs/posts; Express agreement/disagreements
- Create a collaborative network learning environment and practice organizing online discussion forums (Google groups, Twitter)
- Find/select free audio and video recording software, and create audio/video resources
- Create an online quizzes and surveys
- Create various interactive presentations
- Share digital resources in various formats and comment on others/ evaluate etc.

During the COVID 19, online or distance education has become exceedingly engaging and our research has carried utmost relevance and has been conducted at a high time to enhance students' digital knowledge and skills. Digital competence can prepare students for their future endeavors and ongoing professional growth per the modern education and digital transformation needs.

Data collection

The researcher utilized a questionnaire consisting of 20 different questions in order to collect data for this study. Both the control group and the experimental group were given a copy of the questionnaire twice (once as a pretest and once as a posttest). The questionnaire was distributed to both sets of respondents at the same time. The data were transformed into three different scale ranges: low (code 1), medium (code 2) and high (code 3). The researcher then distributed the scores based on the experimental groups, analyzed the results of the classical assumption test and tested the hypothesis after they had finished scoring the questionnaire responses.

Data analysis

The primary data analysis of this study was to test the hypothesis that independent variables have an effect on the dependent variable. Accordingly, the general characteristics of data were reflected in the descriptive statistics before hypothesis testing was carried out.

Normality test

The normality test is used to determine the data's normality level. The normality test was also employed as a determinant test in this investigation. The Kolmogorov-Smirnov test was used to determine whether or not this data was normal. If the Kolmogorov-Smirnov significance value is greater than 0.05, the data is considered normal (Ghozali, 2018).

Homogeneity Test

Homogeneity test was used to determine the level of similarity of variance between two groups of data (pretest and posttest). This test is carried out by Levene's test. The criteria for testing the data are said to be homogeneous if Levene's test produces a significance value above 0.05 (Sugiyono, 2018).

Descriptive statistics

Descriptive statistics are used to find out the initial description of the research data, both demographic data and parameter data (Ghozali, 2018). The analysis appeared in terms of central tendency, mean and rate percentage.

Hypothesis testing

Hypothesis testing refers to the assumption of normality and homogeneity being tested. The homogeneity of variance test is used if the two analyzed datasets are normally distributed. Non-parametric statistical tests the Mann-Whitney test (U-test) was used to determine if the two sets of data being compared are not normally distributed (Sugiyono, 2018).

Results

Normality and Homogeneity Test

The results of the normality test using the Kolmogorov-Smirnov test and homogeneity using the Levene's test can be seen in table 5:

Table 5.
Normality and Homogeneity Test

Level	Group		Kolmogorov-Smirnov Test			Levene's Test	
			Statistic	df	Sig	Statistic	Sig
Motivational Component	Experiment	Pretest	0.165	60	0.000	0.039	0.843
		Posttest	0.132	60	0.011		
Technological Component		Pretest	0.231	60	0.000	0.941	0.334
		Posttest	0.176	60	0.000		
Cognitive Component		Pretest	0.280	60	0.000	16.464	0.000
		Posttest	0.189	60	0.000		
Ethic Component		Pretest	0.303	60	0.000	8.751	0.004
		Posttest	0.136	60	0.008		
Motivational Component	Control	Pretest	0.199	87	0.000	0.163	0.687
		Posttest	0.183	87	0.000		
Technological Component		Pretest	0.226	87	0.000	0.941	0.334
		Posttest	0.212	87	0.000		
Cognitive Component		Pretest	0.303	87	0.000	16.464	0.000
		Posttest	0.262	87	0.000		
Ethic Component		Pretest	0.294	87	0.000	8.751	0.004
		Posttest	0.317	87	0.000		

Based on the table above, it is known that all the data used in the study are not normal because they have a Kolmogorov-Smirnov significance value below 0.05. Therefore, hypothesis testing can be continued by using the Mann-Whitney test even though there is a Levene's test on several parameters indicating that the data is homogeneous which is marked with a significance value below 0.05.

Descriptive statistics

Descriptive statistics in this study were used to see the demographic description of the respondents used. The results of the descriptive statistics can be seen in table 6.

Table 6.
Descriptive statistics

Group	Demographics	Category	Frequencies	Percentages
Experiment	Gender	Male	18	31,67%
		Female	42	68,33%
	Age	< 20 year	7	11,67%
		≥ 20 year	53	88,33%
	Experience using digital teaching methods	inexperienced	34	56,67%
		1 year	18	30,00%
		> 1 year	8	13,33%
Control	Gender	Male	29	35,63%
		Female	58	64,37%
	Age	< 20 year	22	25,29%
		≥ 20 year	65	74,71%
	Experience using digital teaching methods	inexperienced	45	51,72%
		1 year	25	28,74%
		> 1 year	17	19,54%

Based on the table above, it can be seen that in the experimental group there was a dominance of the female gender as many as 41 people (68.33%) compared to the male gender which was only 19 people (31.67%). There is an age dominance in the experimental group where respondents aged 20 years are 53 people (88.33%) compared to respondents aged < 20 years which are only 7 people (11.67%). The experimental group is also dominated by respondents who are inexperienced in using digital teaching methods as many as 34 people (56.67%) than respondents with 1 year experience as many as 18 people (30%) and respondents with more than 1 year experience as many as 8 people (13 ,33%).

In the control group there was also a dominance of the number of female genders as many as 58 people (64.37%) than the male gender which was only 29 people (35.63%). There is an age dominance in the control group where respondents aged 20 years are 65 people (74.71%) than respondents aged < 20 years which are only 22 people (25.29%). The control group is also dominated by respondents who are inexperienced in using digital teaching methods as many as 45 people (51.72%) than respondents with 1 year experience as many as 25 people (28.74%) and respondents with more than 1 year experience as many as 17 people (19,54%).

Hypothesis testing

Hypothesis testing was carried out in this study using table 7.

Table 7.
Hypothesis testing

Group	Statistics testing	Motivational Component	Technological Component	Cognitive Component	Ethic Component
Experiment	Mann-Whitney U	1364.500	1195.000	722.500	1048.000
	Wilcoxon W	3194.500	3025.000	2552.500	2878.000
	Z	-2.314	-3.264	-5.882	-4.073
	Asymp. Sig. (2-tailed)	.021	.001	.000	.000
Control	Mann-Whitney U	3732.500	3617.000	3641.000	3649.500
	Wilcoxon W	7560.500	7445.000	7469.000	7477.500
	Z	-.161	-.526	-.466	-.441
	Asymp. Sig. (2-tailed)	.872	.599	.641	.659

Based on the table 7, it is known that all the significance values in the experimental group resulted in a significance value below 0.05. The results show that the MOOC treatment given can produce significant differences in the four structural components (motivation, technology, cognitive and ethical) digital competence of prospective teachers in the pretest and posttest experimental groups or Ha_1 accepted.

As a comparison, the same statistical test was carried out in the control group, where this group was not given MOOC treatment either in the pretest or posttest. The statistical test results in the table show that all parameters produce a significance value above 0.05. That is, the absence of the MOOC treatment that was given could not produce significant differences in the four structural components (motivation, technology, cognitive and ethical) digital competence of prospective teachers in the pretest and posttest control groups or Ha_2 rejected.

Discussion

This empirical research can be relevant as it aims to develop digital competence-specific components that have not been thoroughly investigated before. The differences between the initial and final experiments' results between the components and the participating groups' comparative analysis indicated the positive results in the development stage. Researchers have reported that several factors, including content, interactivity and accessibility, substantially improve students' motivation in MOOCs per the motivational component (Deshpande & Chukhlomin, 2017). These authors disclosed that concise video materials, resources and assistance tools, along with support instructions, enhanced students' attention for better learning regarding the content. To that end, "Introduction to MOOC" provided the essential theoretical, brief video or text materials for prospective teachers for digital competence and the pertinent hypothetical materials needed to produce digital resources for MOOCs. The content's logical organization was easy to navigate and the final research results verified the MOOCs' accessibility at any time, thanks to the Internet. The flexibility of multimedia materials, the possibility of discussing professional issues with peers, the high interaction and the course's overall flexibility developed students' positive motivation. Moreover, they increased their technological awareness and cognitive skills. Usually, the successful implementation of these factors can jointly develop the digital competencies of all the components.

Previous research has revealed that MOOCs are tools for continuous learning. Yet, they do not develop digital skills (Soyemi et al., 2018). Also, other researchers disagree and state that MOOCs' participatory nature develops digital skills (Rivera & Ramírez, 2015; Wambugu, 2018). MOOCs' participatory character allows accessing information or learning materials, the Internet or collaborative tools develop human cognitive skills (McAuley et al., 2010). Thus, this empirical study confirmed that it was beneficial for students to combine theoretical knowledge with experience throughout the course and the students were able to create various digital resources by sharing and exchanging fruitful professional experiences. But the situation in the control group was relatively different from that in the experimental group, as the group did not take part in the MOOC, was not guided to complete assignments and implemented their practical assignments. However, universities do not agree that developing students' digital competencies result in critically effective ways to develop digital competence. Thus, higher institutional organizations training prospective teachers should consider striking ways to develop general competencies, including digital competence, such as MOOCs. Educational organizations and their leaders should exhibit an effective "digital

management" model to improve teachers' pedagogical competence in their everyday professional activities, affecting others' pedagogical competence (Masur, 2021).

Conclusion

To sum up, developing prospective teachers' digital competence is an exceedingly crucial issue. The development of artificial intelligence will not cease and with novel technologies' advances, one must acquire new skills or be ready to adapt to emerging changes. Therefore, the following conclusions are formulated based on the research findings and data analysis. First, the teaching method via distance education technologies, such as MOOCs and education relying on various network types, can effectively develop digital competence's all the components. Then, the MOOCs' development and implementation in the higher education system in Kazakhstan, with prospective and current teachers improved digital competence, will pave the way for lifelong learning by launching an open educational space in the country. Future research can provide an in-depth analysis of network discussions and their potential as a knowledge-building tool to overcome didactic challenges.

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