Developing Digital Competencies of Secondary Education Teachers: Case Study of Professional Development Courses

Andrei S. Shustrov[a], Ivan V. Smertin[b], Petr A. Petryakov[c]
Institute for Continuous Pedagogical Education, Yaroslav-the-Wise Novgorod State University, Chudintseva, 6/64, Veliky Novgorod, Russia
shustroff.andrej2011@yandex.ru, iwan.smertin2@gmail.com, pap15@yandex.ru

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Abstract: This article provides a comprehensive study of digitalization of Russian schools and digital literacy of schoolteachers. The authors examined different aspects of digital literacy development among schoolteachers both in Russia and abroad. The authors highlight the peculiarities of organizing the learning process using innovative digital technologies, emphasizing the importance of neural networks and online portals. The authors describe the concept of Digital Didactics Laboratory that assists teachers in enhancing digital competence. Quantitative and qualitative results of an empirical study on the level of development of IT competencies among teachers of the Novgorod region are presented. According to the results, all participants of the qualification enhancement program have acquired new knowledge and digital skills relevant to their roles as schoolteachers. The authors identify various difficulties faced by teachers during the implementation of the professional development program. The difficulties were caused by a lack of digital literacy skills. The results of the study will become the basis for the development of future advanced training courses.

1 INTRODUCTION

Multilevel digitalization of the Russian education system, which was prompted by temporary restrictions on face-to-face classes in schools and universities during the COVID-19 pandemic, has revealed various problems of organizational, infrastructural, and competency nature. According to UNESCO, virtually 87% of the world's students - 1.5 billion children, adolescents and young adults in 180 countries - have switched to distance learning due to the COVID-19 pandemic (UNESCO, 2020). While the vast majority of university teachers have already had experience in using various digital tools (in particular, videoconferencing software and platforms for creating distance online courses, which are used in various forms of university education, e.g. full-time, part-time, part-time, evening, as well as in active cooperation between Russian universities and foreign colleagues), for schoolteachers, "forced" digitalization during the pandemic became a serious challenge that not all of them were able to overcome effortlessly. Moreover, while university students are independent and fully responsible for their own academic performance and attendance, the organization of the educational process at school depends to a greater extent on teachers, and, in addition, parents. The transition to the distance format and the difficulties associated with it have led to occasional conflicts between parents, teachers and school administration. Russian section of YouTube and other popular video hosting sites are full of videos with the titles "Parents get mad from distance learning", "Horrors of distance learning at school", etc. Various portals of public initiatives publish petitions with demands to legally ban distance learning. Large educational conferences and round tables organized, for example, by representatives of "Yandex. Textbook" are devoted to the topics such as

[a] https://orcid.org/0000-0002-2052-7761
[b] https://orcid.org/0000-0001-7383-4549
[c] https://orcid.org/0000-0002-9629-2524

"Parents against distance learning. What should a school principal do?".

It is very important to determine the position of the teachers in the situation we are considering and to identify their ability to influence the effectiveness of the organization of distance learning and the use of digital educational tools. Currently, general education schools in Russia use such tools as online educational platforms, catalogs and electronic workbooks (YaClass, Uchi.ru, SkySmart, Google Classroom, Yandex. Textbook, FoxFord, Stepik, Digital Educational Content, 1C: Lesson), social networks (VK), messengers (VK messenger, Viber, WhatsApp, Telegram), video conferencing services (Zoom), as well as services for working with graphics and sites for creating game-based learning materials (Kahoot, LearningApps, Supa, AhaSlides) (Zolova, 2022). Each of these tools undoubtedly has a user-friendly interface and provides users with materials that allow for a thorough study of its functionality. However, they are designed in accordance with the requirements of UI/UX (user interface/experience design) and so-called "digital ergonomics," which does not always meet the requirements of inclusivity, especially "age inclusivity." For many young people, both so-called "digital natives" and representatives of Generation Y, interacting with various services in the digital environment poses no significant difficulties. Unfortunately, people of these generations are not represented widely in Russian schools. The author of the study on the age structure of the teaching staff in general education schools in the regions of Russia, Pin'kovetskaya Y.S., found that the proportion of educational workers belonging to each of the following age groups was as follows: up to 30 years old - 13.4%; from 30 to 39 years old - 19.1%; from 40 to 49 years old - 26.1%; from 50 to 59 years old - 27.2%; 60 years old and older - 11.1%. Consequently, 64.4% of school teachers belong to the middle and senior age group (Pinkovetskaya, 2022). According to a study by the multidisciplinary analytical center NAFI, the share of Russians with a sufficient level of digital literacy directly depends on the age of the person. So, the highest levels of digital literacy are demonstrated by people under the age of 44, while the lowest levels of digital literacy are found among Russians over the age of 60 (Mirzoev et al., 2023). As for computer and information technologies, there are certain difficulties for the senior generation in mastering them. The data we have reviewed leads to disappointing conclusions: a significant, if not overwhelming, share of the human resources potential of Russian secondary schools is in the "risk group" when it comes to digital literacy.

In addition, mastering digital tools and developing new skills requires sufficient time and motivational resources. According to the results of sociological surveys of parents of schoolchildren, a modern progressive teacher ought to be energetic, educated, easily adaptable to changes professional with excellent knowledge of their subject and teaching methods (Petrash et al., 2021). Indeed, in vitro such a school teacher will most effectively respond to the digitization of the educational process and timely adapt to the changes. The question arises as to whether modern school teachers have sufficient internal and external resources to form such an approach to functioning in a modern educational environment. In various thematic communities, you can find countless comments like "My husband, who works at a factory, claims that it is difficult to find a busier and more powerless person than a teacher." "A factory worker doesn't bring his machines home, a doctor doesn’t see patients after work, but a teacher is busy even at home twenty-four hours a day, seven days a week." Indeed, the workload of teachers (preparation for classes, conducting classes, class management, performing administrative tasks, formal duties, homework checking, extracurricular activities) leaves most of them with neither time nor motivation for individual development of new competencies, even if they have internal motivation or external stimuli. We fully agree with the statement of the author of the study "Causes of time shortage among teachers of different age groups" Sokolova E.A: "People who are most in need of time always point out the lack of it. Especially those who set significant goals for themselves and strive to achieve them. Teachers are among them» (Sokolova, 2015).

Summarizing all of the above, let us define the research objective. We aim to determine the readiness of teachers in general education schools to use digital technologies in their professional activities and/or to study these technologies, as well as to identify tools that contribute to the development of the necessary skills for teachers of all ages.

Questions of developing digital literacy and modern competencies among school teachers are actively studied both in Russia and abroad. The term "digital literacy" appeared in Russian science over 15 years ago (in 2010) and became part of a synonymous range of concepts presented in research in the field of information and communication technologies ("information competence", "computer literacy", "ICT competence", "ICT culture", "media literacy", etc.) (Evstigneev, 2014). Researchers Eltsova O.V. and Emelyanova M.V. define digital literacy as “the personal education of a subject that includes the following components: a system of knowledge, skills, and abilities in the field of using digital resources and digital information, positive motivation for digital activity, positive experience in working on the Internet; ability to find, evaluate, use, disseminate and create content using modern information technologies" (Eltsova et al., 2020). Researchers note that digital literacy is not an inherent quality and is not acquired spontaneously: it is a system of knowledge, skills, and attitudes necessary for life in a digital society (Aymaletdinov et al., 2019). In Western thought, the development of concepts of digital literacy abroad begins with the monograph by P. Gilster "Digital Literacy", which was published in 1997 and defined this phenomenon as the ability to understand and use information provided in a variety of formats and a wide range of sources via computers. P. Gilster included media literacy, critical thinking ("caution"), emphasized the need for communication with other users, expanding creative possibilities, and developing active behavioral patterns of a person on the Internet (Gilster, 1997). Following Gilster, D. Belshaw identifies eight aspects of digital literacy: cultural (the culture of behavior on the Internet, from netiquette to privacy protection), cognitive (computer literacy, skills in working with software), constructive (the ability to create media products on the Internet while respecting copyright), communicative (skills in constructive communication in the digital environment), confidence (the ability to become a full member of the online community), creative (the ability to create something new using online tools and environments), critical (analysis and evaluation of digital content, tools, and applications), civic (the ability to use the digital environment for self-organization) (Belshaw, 2015). N. D. Berman understands digital literacy as a set of knowledge and skills necessary for safe and effective use of digital technologies and internet resources: "Digital literacy is the ability of a person to use digital tools (in the broadest sense) for their own benefit." He identifies three components: digital competencies (such as internet search skills, critical evaluation of information, ability to create multimedia content, use of mobile communication devices, online tools for obtaining services and goods, etc.), digital consumption (level of accessibility and use of digital technologies), and digital security (mastery of skills for safe work on the Internet, culture and ethics of online communication) (Berman, 2017).

When considering the concept of digital literacy in relation to educators, researchers add a component related to their professional activities, namely the ability to apply digital technologies in pedagogical practice (Polyakova, 2019). Usually, the development of general and specific digital competencies, both in Russia and in the West, is a task of the system of teacher advanced training and professional development (Tsvetkova et al., 2019). In the process of developing digital literacy of teachers, a number of relevant tasks related to the motivational component can be identified. So, G. U. Soldatova and E. I. Rasskazova in their research have found a significant "gap" between general motivation, determining the orientation towards activities aimed at improving digital competence, and specific motivation, determining the "range of specific, special tasks that arise in the process of active internet use", observed in both children and adults. The researchers' recommendations included the idea of the need to form "specific goals and intentions" among students when implementing educational programs in the field of digital literacy (Soldatova et al., 2017).

It should be noted that the development of teachers' digital competencies should be ongoing, as new digital technologies appear every year, radically transforming the educational landscape of secondary schools. In this Fourth Industrial Revolution era, teachers can do their job either in a classroom or via online platforms using various tools such as, for example, chatbots (Mendoza et al., 2020, pp. 93–107.). Chatbots are conversational or interactive agents that provide instant response to the user (Okonkwo et al., 2020). Chatbots are based on language models: sets of data combined with artificial intelligence and natural language processing tools to simulate conversations with humans. For example, the most famous conversational chatbot, ChatGPT, is based on the GPT 3.5/4 language models. ChatGPT was invented by OpenAI and released in 2022, attracting the close attention of both experts and all more or less proficient Internet users (Zashihina, 2023). Undoubtedly, the use of Artificial Intelligence (AI) in education is rapidly expanding (Roos, 2018). Chatbots are being considered as a useful technology to facilitate learning within the educational context (Clarizia et al., 2018). The emergence of artificial intelligence and chatbot technology has brought a new dimension to the digitization of secondary education. Thus, studying and designing automated processes using AI is an important and relevant task of IT education in schools (Mirzoev et al., 2023). Chatbots in schools have the potential to fundamentally change the principles of interaction between students and educators, both among themselves and with digital resources. Researchers believe that it is possible to say that just as computers have become an integral part of technical and natural sciences, so will text analysis, evaluation, and generation systems become an integral component of education at all levels, too (Ivahnenko et al., 2023). Intellectual virtual assistants can provide students with instant access to information, help with homework, and even offer personalized learning materials. Chatbots will help simplify the execution of administrative and other routine tasks, allowing teachers to devote more time to professional development, education, and student support. They can also serve as an additional tool for asynchronous learning, providing students with round-the-clock access to educational materials, tests, and feedback.

The most promising chatbots in the context of education are bots that operate based on generative models. Generative models aim to generate data according to their datasets and human input. For example, a good generative model trained on a collection of human face images, should be able to generate new faces with various facial features and expressions that are not close to any of the training images (Liu, 2020). In turn, large generative models, which were trained on a huge amount of textual information, such as GPT-3, GPT-3.5, GPT-4, are capable of generating texts upon user request, the quality of which is improving every day. Moreover, chatbots based on generative neural networks can assist students in solving mathematical problems, learning vocabulary in a foreign language, or even provide detailed and personalized explanations of scientific concepts. In this context, chatbots act as personal tutors.

Modern no-code or low-code chatbot building systems allow to create virtual assistants that manage schedules, process routine requests, and facilitate communication between teachers, students, and parents.

Of course, chatbots open up a multitude of extremely interesting opportunities for teachers and schoolchildren. But we must remember that the competence of the teacher in this field is paramount. Teachers play a crucial role in the effective integration of chatbots into the educational process, because they have an extensive experience in educational sciences and teaching practice. Such experience can guide the development and implementation of chatbots to ensure their alignment with common and specific educational goals. Teachers can organize interaction with chatbots in accordance with specific educational programs and age groups of students, thereby complementing and expanding the possibilities of traditional forms of education.

As we mentioned before, chatbots open up promising opportunities for improving the system of general education, however, at present, they should be considered as additional tools that complement the teacher's activities rather than replacing them.

Chatbots are not the only modern tools that can facilitate teaching and organize asynchronous learning. With the emergence of website creation platforms that require no specific programming skills or coding competences (Wix, Tilda, WordPress and others), the field of organizing and providing digital content on the Internet has undergone significant changes. These platforms provide teachers with a powerful tool for creating their own websites, offering a wide range of possibilities to enhance the effectiveness of pedagogical activities and the learning process. Today, being present in online space is very important for everyone who wants to keep up with the ways young people are communicating with each other. Creating personal websites for teachers on different platforms allows teachers to interact with students, parents, and the wider community in innovative and engaging ways. Using blogs or discussion forums, teachers can share important announcements, update homework assignments, and class news. Such dynamic interaction contributes to the formation of a sense of community in the classroom, informing and involving everyone in the educational process.

One of the main advantages of using such services is the ability to create and distribute individual educational resources. Teachers can create special pages for each subject they teach, where lecture notes, assignments, and additional educational materials are uploaded. This allows not only to simplify the presentation of the material, but also to provide easy access for students to the necessary materials, which contributes to a more organized and effective learning process.

School teachers' websites can serve as a platform for showcasing their students' achievements. Teachers can create galleries to showcase student projects, artwork, or essays. This not only boosts the morale of the students, but also demonstrates the teacher's desire to acknowledge and celebrate their achievements.

It is important to note that teacher’s expertise plays an important role in shaping students' digital literacy. They can help students navigate and effectively use not only their own websites and chatbots, but also the outside ones, thus developing their critical thinking alongside with digital skills.

The ability of teachers to use digital tools effectively is closely linked to increased student engagement. The integration of multimedia resources, gamified learning and interactive platforms allows teachers to capture the attention of students, making learning not only informative but also enjoyable. Engaged students are more likely to retain knowledge and demonstrate higher motivation to learn, leading to improved educational outcomes.

Digital literacy is synonymous with adaptability. In an ever-changing technological landscape, teachers must stay abreast of the latest educational technologies. The ability to quickly incorporate new tools into teaching practices allows teachers to respond to the changing needs of students, ensuring educational relevance and effectiveness.

Given the multifaceted benefits of digital literacy for both teachers and students, there is an increasing need to promote its development in the educational community. Effective development of digital literacy for school teachers requires a comprehensive system that includes teacher training, curriculum integration, ongoing professional development, and collaboration among educators. Such a system will not only equip teachers with the necessary digital competencies, but will also enable them to navigate the digital landscape with confidence, providing effective preparation to meet the challenges of modern education.

The Digital Didactics Laboratory of Yaroslav-the-Wise Novgorod State University, established in July 2021, was created to serve the abovementioned purpose. V.I. Blinov defines digital didactics as “a branch of pedagogy, scientific discipline on the organization of the learning process in the digital society", as the transfer-integrative area of scientific knowledge” (Blinov, 2019). The Laboratory is formed to promote the development of digitalization of education, especially in the Novgorod region. Its multifaceted approach is in line with the overall goals of improving the digital competence of teachers and forming a technologically advanced educational environment.

Its mission encompasses a wide range of initiatives that directly contribute to the development of digital literacy for teachers in the region. The Laboratory conducts scientific research, promotes digitalization of education, introduction of digital didactics technologies, creation of digital educational resources. Moreover, the Laboratory provides methodological support, carries out research projects and disseminates research results. Each of these components plays a crucial role in improving the digital literacy of teachers in the Novgorod region.

One of the central tasks of the Laboratory is to conduct scientific research projects dedicated to modern problems and possibilities of integrating digital tools into the educational process. Based on these studies, the Laboratory develops strategies for improving digital literacy among teachers.

The Laboratory actively implements modern pedagogical principles into the educational process of various educational institutions in the Novgorod region through the development and implementation of digital didactics technologies. This allows teachers to adapt to the changing digital landscape, enhance their level of digital competence, and create a more interesting and effective learning environment for their students. In addition, the Laboratory develops digital educational resources that adhere to modern principles of pedagogical design, providing teachers with the necessary materials to enrich the learning process.

Consulting and methodological support for university teachers, schoolchildren, and school teachers is one of the main areas of activity of the laboratory. This support contributes to the practical application of digital educational resources and the development of digital literacy of educators at all levels. The Laboratory actively participates in the development and implementation of research projects dedicated to digitalization of education, offering practical solutions to enhance the digital competence of teachers.

In order for the research results to benefit the wider professional and educational community, the Laboratory disseminates via publications in scientific journals. Moreover, knowledge exchange occurs in both offline and online formats: Laboratory organizes seminars, workshops, as well as online/offline advanced training courses.

Thus, the Digital Didactics Laboratory of NovSU is a center for the development of digital literacy among schoolteachers. The Laboratory offers a multifaceted approach that aligns with the broader mission of developing digital literacy in the modern educational space.

Recently, the Laboratory conducted professional training courses for teachers dedicated to creating chatbots and personal websites using no-code resources. These courses are of great importance for modern teachers: they meet the growing demand for promoting digital literacy and innovative teaching methods in educational institutions.

In a world where technology plays an increasingly important role in education, these courses allow teachers to adapt to the digital era and enrich the learning process for their students. The transition from traditional to online and blended learning models requires teachers to acquire skills in creating digital resources and increasing student engagement in the virtual environment. These courses allow teachers to become more adaptable and resourceful in the face of these changes.

Special attention is be paid to the accessibility and flexibility of these courses. The courses gradually transitioned fully to online platforms, so they can be attended by teachers from different regions, which allows to overcome geographical barriers and provides the opportunity to improve the level of digital competence for a larger number of teachers, including those from remote areas.

Digital transformation of education raises a number of questions related to the readiness of teachers for the digitization of education, their ability to effectively use modern digital tools in the educational process, and to develop digital literacy among students (Golodov et al, 2022).

2 MATERIALS AND METHODS

The following theoretical and empirical methods were used in the conducted research: theoretical analysis of psychological, pedagogical and philosophical literature, as well as normative documents on the research problem; analysis of teachers' experience of working in the digital educational environment of modern schools; online survey method (via questionnaire for teachers of different subjects); quantitative and qualitative analysis of survey results.

The research is based on an environmental approach, which allows determining the qualitative indicators of the formation of knowledge and skills among educators in the field of IT application in the digital educational environment. To determine these indicators, the authors of the article conducted a survey among 67 schoolteachers from general education organizations in Veliky Novgorod. The author's questionnaire consisted of 17 questions, which can be divided into 2 blocks: the first block allowed to identify the level of participants' knowledge and skills in the field of distance learning systems; the second block of questions allowed to identify various difficulties faced by teachers in mastering the training program in order to further improve the effectiveness of distance professional development courses developed by the Digital Didactics Laboratory of NovSU. Data collection and statistical processing were carried out using Google Forms.

3 STUDY RESULTS

Readiness for using digital technologies in professional activities is formed by a multitude of factors. Among such factors, internal motives should be highlighted as the most representative psychological category that determines the level of interest of teachers in professional development. The survey results showed that self-development is the main reason for the overwhelming majority of respondents (68.8%) to take professional development courses. Teachers have noted other reasons as well, for example, mandatory professional development requirements (31.3%) and requirements from the educational organization administration (31.3%). Only a few survey participants (6.3%) indicated that they took the courses because the subject matter of the educational program was related to their professional activities. Thus, two main groups of teachers can be distinguished: enthusiasts: those who are interested in professional development; and formalists: those who simply fulfill their obligations to the educational organization management.

Internal readiness is a characteristic of a person, the core of which is a positive assessment by the individual of their own skills and abilities. This is just as important a factor as motives. According to the research results, the overwhelming majority of respondents (68.8%) expressed their internal readiness to apply certain aspects discussed within the framework of the professional development program in their professional activities. At the same time, there are other teachers (25%) who have indicated a complete internal readiness to use artificial intelligence tools for creating educational content in order to enhance the effectiveness of the learning process. Only a small part of the respondents (6.3%) noted that they do not intend to apply the acquired knowledge at school.

The professional development program included studying not only new digital tools, but also methods of implementing traditional techniques and interpersonal interaction in the educational process. Therefore, an important indicator of the quality of the content of the professional development course became the identification of personally significant learning outcomes for each teacher. According to the data obtained from the survey, a significant portion of teachers (68.8%) indicated that they acquired new knowledge, skills, and broadened their horizons during the learning process. Among the respondents, there are quite a few teachers (43.8%) who, as part of the continuing education program, systematized their existing knowledge and skills in the field of digital technologies. Some survey participants (31.3%) noted that communication with colleagues who organized and conducted professional development courses will increase the effectiveness of their professional activities. In addition, some teachers (31.3%) highlighted that the optimization of interaction with parents through digital technologies is important for them. Other educators have indicated that upon completion of their training, they will review their own working methods (12.5%) and address issues of improving the quality of the educational process using new knowledge in the field of digital technologies (6.3%).

The next set of questions concerns the various difficulties that educators have encountered during the professional development program. The most challenging actions for educators were as follows: constructing a chatbot on the no-code platform (18.8%), publishing the chatbot on the messenger

(12.5%), constructing a personal website (12.5%), integrating the chatbot into the personal website (12.5%), publishing the personal website on the Internet (18.8%), registering a Google account (6.3%). Thus, it can be concluded that the vast majority of teachers have managed to fully master the professional development program. Some difficulties were associated with the process of memorizing certain steps that need to be taken to achieve the desired result, which was expected since teachers were not previously familiar with the digital technologies used. Among the factors that hindered the successful mastering of the advanced training course program teachers noted a lack of digital skills (search for information and overall digital literacy). These results will be taken into account when developing the next professional development courses, which should be aimed at developing, first and foremost, digital literacy of teachers.

Next, respondents were offered several established public judgments for discussion, describing the impact of digitization on the conditions of work in the educational process. It should be noted that the overwhelming majority of teachers did not express a categorical "agree" or "disagree". A significant part of the respondents rather agree that the implementation of IT technologies significantly changes the role and functions of a teacher, while there were also teachers who expressed their cautious disagreement with this statement. The opinions of teachers regarding the widespread use of distance education courses are divided evenly: some educators are convinced that the spread of distance courses does not affect the quality of education; on the contrary, another group of teachers believes that the use of distance courses can significantly reduce it. Moreover, many teachers are concerned that the possible transition of the educational process to a remote format may lead to a reduction in the number of teachers, especially from the older age group. The overwhelming majority of participants of the survey agreed with the opinion that the implementation of IT creates an additional workload. At the same time, the majority of teachers noted that modern digital and information technologies improve the communication between the teacher and the student.

The participation of educators in the professional development course has allowed them to acquire practical skills in implementing specific digital technologies into their professional activities, which will further contribute to improving the quality of the educational process. The main indicators of effectiveness highlighted by educators include: increasing status within the pedagogical community, enhancing students' academic motivation, improving interaction with parents and students outside of school hours, refining the process of diagnosing students' knowledge and skills, improving academic performance and students' participation different competitions, enhancing exam results, etc.

4 CONCLUSIONS

The obtained research data provide grounds to believe that all participants of the advanced training course have acquired new knowledge in the field of digital technologies, which can be applied by them in their professional work with both students, parents, and colleagues. Nevertheless, some educators experienced serious difficulties in mastering the training program, as they did not fully possess the basic computer skills. We found that it is necessary to develop an online course on digital literacy. Digital literacy, according to the definition of UNESCO, includes a set of fundamental knowledge and skills that enable the development and use of digital resources, the search and processing of data, and the interest in social networks for content creation and sharing with other users (UNESCO, 2018).

The course on digital literacy for teachers must consist of several educational modules: informational, communicative, computer literacy, media literacy, attitude towards technological trends. Each of the listed indicators will be evaluated in three aspects: cognitive (knowledge), technical (skills), and ethical (attitudes) (Aymaletdinov et al., 2019). Studying digital literacy will allow teachers to alleviate stress when working with computers, thus speeding up the process of acquiring various digital skills such as website development, digital educational resources, applications, virtual trainers, and simulators; creating chatbots, channels, and communities for interaction with students, parents, and colleagues.

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