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Характеристика профессиональных компетенций учителя информатики в цифровой образовательной среде: цифровая компетентность

Актуальность. Цифровые технологии находят широкое применение в системе общего образования. Важным вопросом становится формирование цифровой грамотности школьников. Особая роль при этом отводится учителю информатики. Необходимо дополнительное исследование состава профессиональных компетенций учителя информатики в цифровой образовательной среде, формирование цифровой компетентности, его готовности стать наставником обучающихся в овладении ими цифровыми навыками. Средствами формирования цифровой компетентности служат практикоориентированные задания на использование цифровых технологий в педагогической практике.

Цель статьи заключается в систематизации решаемых педагогом в цифровой образовательной среде задач и разработке рекомендаций по формированию цифровой компетентности учителя информатики.

Методология и методики исследования. Методологическую основу исследования составляют идеи системного и компетентностного подходов при определении сущности цифровой компетентности и характеристике успешности педагога в цифровой образовательной среде на основе сформированной цифровой компетентности, готовности учителя стать наставником школьников в познании цифрового мира и формировании цифровой грамотности обучающихся.

Результаты исследования представлены описанием практикоориентированных творческих заданий, которые направлены на формирование цифровой компетентности учителя информатики и систематизированы по областям цифровой грамотности по группам цифровых компетенций.

Научная новизна обусловлена использованием при разработке характеристик цифровой компетентности учителя информатики представления о структуре и содержании цифровой грамотности обучающихся, необходимостью формирования таких цифровых компетенций, которые позволили бы учителю информатики стать наставником для школьников по овладению цифровыми навыками.

Практическая значимость представленных результатов исследования заключается в возможности их использования при разработке контента коммуникативно-цифрового модуля педагогического бакалавриата, при разработке программ дополнительного профессионального образования, обеспечивающих формирование цифровой компетентности педагогов и развитие их профессиональной готовности к использованию на практике инновационных образовательных моделей и цифровых технологий для формирования цифровой грамотности школьников, создания комфортной и безопасной учебной среды.

Ключевые слова: цифровые технологии, цифровая компетентность, цифровая грамотность школьников, цифровые образовательные технологии

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Characteristics of professional competencies of computer science teacher in digital learning environment: digital competence

Relevance. Digital technologies are presently widely used in general education. Formation of learners' digital literacy is becoming an important issue. A special role is given to computer science teacher. There is a need for additional research into professional competencies of computer science teacher in the digital education environment, formation of digital competency, his/her readiness to become a tutor for schoolchildren in mastering digital skills. The means for formation of digital competence are practice-oriented assignments on the use of digital technologies in the pedagogical practice.

The purpose of the paper is systematisation of tasks handled by the teacher in the digital education environment and development of recommendations for the formation of digital competence of the computer science teacher.

Methodology and methods of research. The methodological basis of the research is represented by the ideas of systemic and competency-based approaches in defining the substance of digital competence and characterising the teacher's success in digital education environment based on the formed digital competence, teacher's readiness to become a tutor of schoolchildren in learning the digital world and formation of digital literacy.

The research results are presented by the description of practice-oriented creative tasks aimed at the formation of digital competence of computer science teacher and systematised by digital proficiency areas according to the digital competencies groups.

The scientific novelty, when developing the characteristics of digital competence of a computer science teacher, stems from the use of the notion of structure and content of learners' digital literacy, the need for formation of digital competencies that would allow a computer science teacher to become a tutor for learners in mastering digital skills, in development of digital competence characteristics of a computer science instructor.

The practical significance of the presented research results lies in the possibility of their use in developing the content of the communicative/digital module of pedagogical baccalaureate programmes, in the development of complementary professional education programmes ensuring the formation of teachers' digital competence and development of their professional readiness for practical use of innovative educational models and digital technologies with a view to form the learners' digital literacy, create a comfortable and safe learning environment.

Keywords: digital technologies, digital competence, learners' digital literacy, digital education technologies

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Introduction

The rapid development and widespread introduction of digital technologies in science and practice has had an impact on human lifestyles and activities, requiring appropriate personal adaptation to the new digital reality, acquisition of digital skills required today for successful employment and maximum use of technological resources connected with these skills. Digitalisation has become an opportunity, a positive challenge making it possible to maintain economic advantages and competitiveness. The United Nations (UN) describes our reality as a new digital way of life*. Additionally, it is noted that the current norms are defined by the post COVID-19 epoch which is accelerating digital transformation in many areas: digital economy, digital finance, digital government, digital health system and digital education. Digitalisation supposes turning to digital platforms and digital solutions.

In Russia, with the launch of the “Digital Economy” programme, digitalisation has become one of the strategic objectives of the government, covering all areas of human activity and education, among the others. It is natural to assume that the resource base in training personnel for digital economy should be represented by schools, and teachers of computer science are to become guides to the world of new technologies and create due conditions for the learners’ successful digital socialisation.

Much attention is paid to the formation of the learners’ digital literacy, since it is the young minds that are shaping the common digital space today. It should be noted in this regard that the requirements for digital competence of teaching staff [1], in the first place, computer science teachers, are being formed quite dynamically. The characterisation of the professional portrait of a modern teacher is now focusing on digital competence [2], which is considered today as a normal social order for the pedagogue’s professional training system. The society realises now that investment in technological equipment of schools, along with the formation of teachers’ digital competence, should become a priority [3].

With the onset of the pandemic in 2020, the pedagogues faced the need to learn the basic digital skills quickly. The closure of schools placed the teachers, learners and parents in a completely new situation [4]. The continuation of learning was only possible through alternative means of study. The teachers had to switch to online learning, which required them to use various digital tools and resources to solve urgent problems and introduce new approaches to teaching and learning. The key responsibility for organising the learning process in a distance format (including methodological assistance and information support) was again placed on computer science teachers. At a certain point, “digital skills became an integral part of pedagogical staff’s competencies for successful and timely completion of routine tasks” [5, p. 1789]; the teachers had to adapt to online learning in giving classes in a new format, creating new learning content, differentiating tasks, providing feedback, making assessment through online environment [6]. The tasks involving management, methodological and pedagogical support of teaching process required particular attention. Many teachers, finding themselves in the situation of uncertainty, had to intuitively introduce digital tools and services into their work by trial and error, sharing successful and unsuccessful experience. Over time, the teaching community found a solution through mass-scale acquaintance of teachers with the potential of digital tools in the online learning conditions and demonstrated due examples of work with special services at webinars,

* <https://www.un.org/ru>

master classes and training sessions. At present, talking of the actual practice of teachers' work, one may confirm the achievement of a certain level of mastery in work with the basic digital skills. However, as it turned out, these results relate primarily to the solution of particular practical tasks: familiarity with some individual online services and their occasional use in pedagogical practice towards increasing the learners' motivation and drawing the latter's attention to this domain. Certain issues remain unexplored: information security (cybersecurity), preserving the learners' psychological and physical health and social well-being; instilling responsible, conscious behaviour in the network; compliance with the rules of online etiquette and others.

The *research problem* lies in the need for additional study of the scientific rationale for the systemic use of the digital technology potential in pedagogical activities, addressing the issues of formation of digital competence of a teacher for comfortable, efficient and safe use of digital technologies in professional pedagogical work leading to achievement of due results, improvement of the quality of education, which requires identification of modern strategies for training computer science teachers in the conditions of digital educational environment.

The authors assume that the trend towards digital transformation of education requires inclusion of practice-oriented tasks in all areas of digital literacy in the teacher training programme in order to develop the pedagogue's mastery of the holistic set of digital skills.

The relevance of studying the formation of computer science teacher's digital competence is additionally determined by the fact that professional training and professional development of teachers in the aspect of digital science mastery is one of the most important conditions for digitalisation of education and successful formation of learners' digital literacy. Digital literacy is recognised as a fundamental skill in the digital society, which is crucial for successful realisation of human life roles in the dramatically changing world. Without computer science teachers' mastery of digital competencies and techniques of using digital technologies in the pedagogical, methodological, educational, organisational and managerial activities, any efforts and tools aimed at creating a digital education environment at school and formation of digital literacy in the course of teaching information science will not yield proper results.

The *scientific novelty*, when developing the characteristics of digital competence of a computer science teacher, stems from the use of the notion of the structure and content of learners' digital literacy, the need for formation of digital competencies that would allow a computer science teacher to become a tutor for the learners in mastering digital skills.

Materials and methods

The methodological basis of the research is grounded on the ideas of systemic and competency-based approaches. The systemic approach guides the authors to consider the composition of digital competence within a set of general-user, general-pedagogical and specialist-pedagogical digital competencies. It is assumed that competence includes not only cognitive and technological components, but also motivational, ethical, social and behavioural aspects. The competence approach focuses on comprehending the need for professional training of a computer science teacher in order to engage in active, efficient and creative activity in modern digital education environment and in solving practical tasks pertaining to the teacher's professional activity. It is also needed for the pedagogue's

participation in public life on the basis of the formed digital competence, his/her readiness to become a tutor for schoolchildren in cognition of the digital world and forming their digital literacy. Therefore it requires identification of main strategies in this direction.

The *purpose* of the paper is systematisation of tasks handled by the teacher in the digital education environment and development of recommendations for the formation of digital competence of the computer science teacher.

The achievement of the set goal requires the following objectives: 1) to analyse the requirements for computer science teacher's qualification (requirements of the Federal Educational Standard, professional standards, employers' requirements), to form groups of professional tasks solved by the teacher in the digital education environment, to characterise the approaches to possible methods of the teacher's preparation towards solving these objectives.

In solving the research objectives, general scientific theoretical research methods were used: analysis of statutory documents in the sphere of education, scholarly works by the national and foreign authors on the subject in question, social demands of the society, generalisation of practical experience of computer science teacher training.

Review of sources

As revealed by the authors, the use of digital technologies in the educational process has been a subject of many studies:

1) on the one hand, the scholars stress the potential of digital technologies in solving the goals of personal development, improving the quality of education, realisation of operational control, ensuring efficiency of the process of training and education of the young generation, accessibility, limitless access to a extensive and diverse information, institution of network communities, individualisation of the learning process, mobility in communication with the teacher; on the other hand, they state the absence of "available recommendations and techniques for efficient implementation of digital technologies" [7, p. 73];

2) the problem of providing "ethical, safe and productive operation in a variety of digital environments" is addressed [8, p. 45]; digital technologies contribute to increased motivation and involvement of learners; the extent of use of digital technologies in the learning process is deemed to be a criterion of educational institutions' rating;

3) it is noted that efficient integration of digital technologies into the educational process, professional pedagogical activities and everyday practice requires "continuous professional development of teachers, continual support in the form of advanced training in line with the trends of digital technologies development" [9, p. 1221]. Digital technologies are rapidly changing and evolving; therefore, teachers need to work systematically on their development using the information sources available to them and the information support from the environment as well as free Internet resources. The didactic, risk- and image-specific barriers to digitalisation of education are identified [10].

The researchers argue that the greatest barriers to the integration of digital technologies in the educational process include low digital competence of teachers, their unpreparedness to work in the digital format with the use of distance or mixed learning technologies [11], "absence of technical and pedagogical skills on their part, necessary to integrate digital facilities into learning" [3, p. 9], haphazard application of digital technologies in class, related unconscious estranged perception of modern digital transformations in the educational

policy [12]. It can be considered that developed digital skills represent a prerequisite for appropriate and practicable use of digital technologies in pedagogical activities. In this regard, the authors of this article further addressed the peculiarities of treatment of particular issues connected with the formation of digital skills and digital competence in teachers, as viewed by the national and foreign scholars: the component structure of the phenomenon referred to as “the pedagogue’s digital competence” was considered [13] in terms of motivational/personal, cognitive, pragmatist, reflexive/evaluative aspects; a number of possible criteria and appraisal ratio for digital competence assessment was formulated [2] – in the process of treatment of digital competence formation as a part of professional teacher training.

The paper by D.A. Mezentseva et al. formulates the definition of “pedagogical digital competence”. Due to the lack of clear understanding of the general concept of digital competence and specifics of pedagogical digital competence, pedagogical digital competence is defined as “a set of knowledge, skills and attitudes that allow teachers to make a conscious and correct choice relative to the use of digital tools and related teaching methods and strategies in a particular educational setting, which leads to improved learning process and satisfaction of learners’ and teachers’ needs” [14, p. 90].

In our study, systemic approach was used in defining the core of teacher's digital competence. In this regard, the structure of digital competence within the system of general-user, general-pedagogical and specialist-pedagogical digital competencies was defined [15].

Developing the recommendations for involvement of computer science teacher in active assimilation of the above list of digital competencies, the authors of this article used the theoretical methods of generalisation and classification of professional objective types handled by the teacher, as well as the empirical methods of observation and teacher questioning.

The schematic representation of the teacher’s digital competencies can be presented as follows (Figure 1).

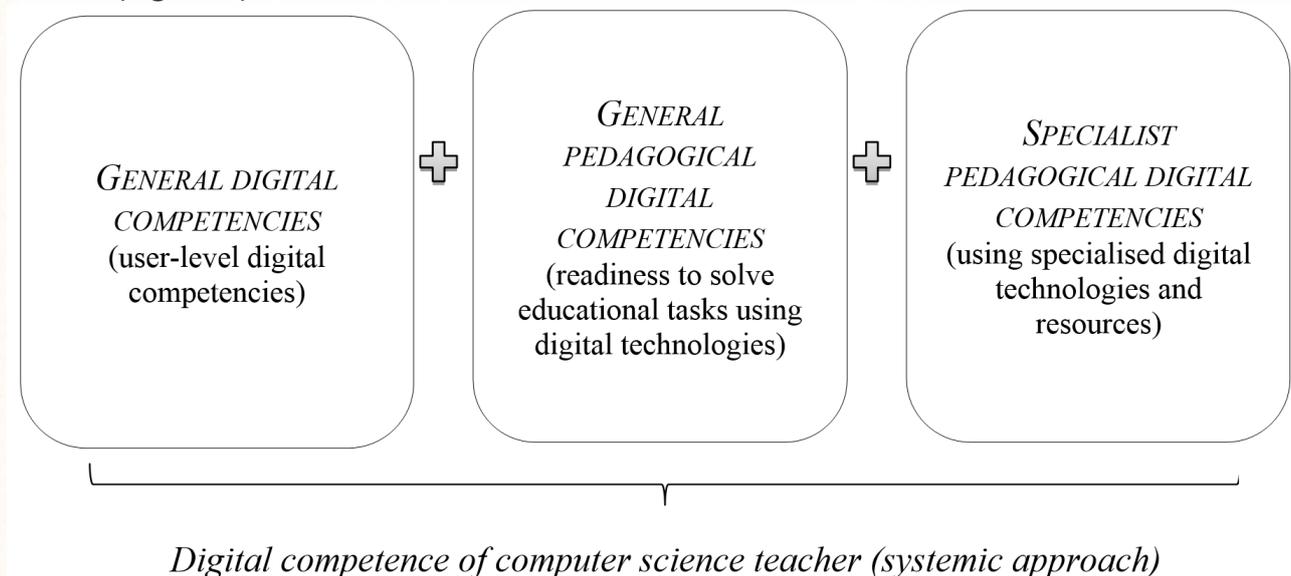


Figure 1 Teacher’s digital competence structure

In this case, the *general digital competencies* are understood as simplest skills, basic digital skills systematically used in everyday and professional context (for instance, the ability to take and process photos and videos, record audio, exchange messages in messengers and via e-mail, search for information on the Internet, work with word processors, spreadsheets, presentations, databases, etc.).

The composition of *general pedagogical digital competencies* includes the teacher's ability to develop/improve teaching through the use of digital technologies in the professional context, scheduling and critical analysis of their activities, organisation of educational process, learners' project activities, development of electronic didactic materials, including interactive ones, use of digital educational resources in the learning process, involvement of learners in active cognitive activity in the digital educational environment, preparation and delivery of consulting sessions for colleagues and learners' parents.

Specialist-pedagogical digital competencies are oriented to expedient and qualified use of digital technologies in professional pedagogical activity, in teaching academic disciplines.

Results

The current stage in the development of the general education system is characterised by increased requirements for the structure of professional competencies of the computer science teacher. Whereas formerly the teacher's compulsory mastery of ICT- (information and communication technologies) competencies was solely required [16], today there is a need for the development of ICT-competencies to the level of digital competencies, formation of the teacher's digital competence [17]. Digital technologies have become a commonplace phenomenon at school, and efficient integration of these technologies puts forward new demands on both the teachers and teacher training programmes. Teaching and modelling the use of technologies as a part of the teaching and learning process requires complex and multifaceted competencies on the part of pedagogues. Digitalisation of the educational environment supposes training of due human resources, as one of the content areas of its realisation: "continuous development of the teachers' digital competence system meeting the requirements of the professional standard for the pedagogue's mastery in ICT competencies and the present level of digital technology development, along with the development of digital tutoring system" [18, p. 7].

In these terms, teachers' digital competence is treated, being part of the modern scientific heritage, as a result of evolutionary development of their ICT-competence, which is presented in the professional standard for pedagogues as an integral characteristic of the teacher in the modern conditions [19, p. 51]; its formation in computer science teachers is recognised to be a central direction of modern educational policy [2].

The terminology and conceptual apparatus in the field of identification of digital reality objects have lately become quite enriched. For this reason, it is advisable to clarify the meaning of the concept "the teacher's digital competence" used in the present research, introduced by the authors in [19, p. 54] and considered as "the teacher's ability to select, confidently, efficiently, critically and securely, and apply ICT and digital technologies in various areas of vital activities in working with content (content creation, search, selection, critical evaluation), organisation of communication (creation, development, maintaining relationships, identity, reputation, self-presentation); solving consumer problems (use of the Internet for consumer purposes – orders, services, purchasing, etc.) and those of the technosphere (computer and software expertise), as well as the teacher's readiness for such activities". We define the pedagogue's digital competence by relying on the idea stating interdisciplinary nature of digital literacy of learners and of its content, as proposed by the authors in the conceptual model of digital proficiency, in seven areas: hardware and software, information expertise, communication and collaboration, creation of

digital content, problem solving, career competencies. Depending on the complexity of pedagogical challenges to be solved, we present digital competence as a set of general, general pedagogical and specialist pedagogical digital competencies and evaluate it at three levels of development (basic level, digital use, digital transformation), characterising its cognitive, functional and creative aspects in pedagogical activity.

The increased attention to the problem of development of future teacher's digital competencies is confirmed by the modern trends towards digitalisation of the content of educational programmes, updating the curricula of the Bachelor degree programmes in the field "Pedagogical education". Initially, according to the requirements of the federal state educational standard for teacher training at the baccalaureate level, the group of general professional competencies included the ability of a pedagogical training graduate to understand the principles of modern information technologies and use them for solving professional problems. The methodological staff-training recommendations for Bachelor degree programmes based on the common approaches to their structure and content ("The Core of Higher Pedagogical Education") as of November 25, 2021, pay special attention, when defining the key characteristics and parameters of core professional educational programmes, to the digital component. In particular, the following interpretation is proposed in formulating the indicators of universal and general professional competencies:

1) in the aspect "Development and realisation of projects" (UC-2) (*UC = universal competencies*) – teacher's ability to use digital modelling tools and techniques for implementation of educational processes;

2) in the aspect "Communication" (UC-4) – the teacher's ability to communicate in a digital environment in order to achieve professional goals and efficient communication;

3) in the aspect "Security" (UC-8) – the ability to assess risk factors, to ensure personal safety and others' security in everyday and professional life, to maintain the culture of safe and responsible behaviour.

4) in the aspect "Information and communication technologies for professional activity" (OPC-9) (*OPC=general professional competencies*) – the ability to select due modern information technologies and software tools, including those nationally developed, for handling the tasks of professional activity, to use digital resources for solving professional activity problems.

The recommendation developers propose to introduce a communicative-digital module in the pedagogue's professional sphere, for instance, represented by such academic discipline as "Digital education technologies," as well as the practical training aimed at formation of information/communication competencies and digital literacy. The module aims at shaping the teacher's readiness for professional activity in the digital space, including for the use of artificial intelligence technologies.

One can assert that digital competencies today are the tools of man's adaptation in the digital society, while the teacher's digital competency serves as a basis for orientation in the digital world, a condition for the formation of the learners' digital expertise. It makes the teacher an expert in promoting digital innovations at educational institutions [20] and facilitates efficient integration of digital technologies in the pedagogical science [21]. Great expectations are placed on pedagogues with regard to the introduction and use of digital technologies. The pedagogue, to a certain extent, has to decide independently how to use digital technologies in the classroom [22].

The professional standard set for the pedagogue includes, among the teacher's activities within the overall work function "Pedagogical activity in designing and

implementing the basic educational programmes”, the function of developing specific knowledge, due the skills and abilities in mathematics and computer science, the ability to apply information and communication technology tools for solving problems, where necessary; to maintain cooperation with other teachers, to engage in professional use of informational education environment elements with regard for the potential of new elements of such environment that are absent in a particular educational organisation; to use information resources in working with children, including distance learning resources, to help children in mastering and independent use of these resources, etc. The highlighted specialised skills include the masterly skills of using computer tools for visualising data, dependencies, relationships, processes, etc.

It seems expedient, in the current conditions of digital education environment and active implementation of mixed and distance learning in practice, to interpret the stated qualification requirements for computer science teachers in the light of the trends towards digital development of the society. For instance, the required ability “to ensure communicative and practical-study inclusion of all learners in the educational process” may be interpreted as “to organise a work space for open active interaction of learners with the use of digital technologies”. Or, for instance, as to the function ““Educative activities”, to interpret the activity aimed to regulate the learners’ behaviour towards ensuring safe educational environment as the development of the learners’ understanding of the rules of secure interaction in the Internet, mastering the rules of network etiquette and developing the ability to resist cyberbullying and cyberfraud.

Many of the work activities listed in the professional standard, when interpreting them in the context of digital transformation of general education, are directly related in content to the formation of learners’ digital literacy. Among them the following should be singled out, for instance, “development of learners’ cognitive activity, independence, initiative, creative abilities, formation of civic position, ability to work and live in the conditions of the modern world, formation of learners’ culture of healthy and safe lifestyle; formation and realisation of programmes for the development of universal learning actions, models and values of social behaviour, behavioural skills in the world of virtual reality and social networks...” (Professional Standard for Educators, p. 10). Summarising the above, one can note that one of the most important tasks set for computer science teachers is formation of learners’ digital literacy. This fact is confirmed by the data of specialised websites (rabota.ru, hh.ru) as to the requirements for candidates for the position of computer science teacher – not only professional knowledge in the specialist sphere is required, but also the skills demanded in the digital society: shaping the learners’ digital literacy, programming and web development skills, creation of computer games, the ability to work with whiteboards and online instruments, providing visualisation of material and interactive explanations, etc.

It is interesting to note that according to the statistical data on the analysis of pedagogues’ digital competencies, as presented in a study by S.V. Avilkina [23], certain indicators of teachers’ digital competence level were revealed: basic knowledge of office software, difficulties in resolving the problems connected with the installation of software and mobile applications; incomplete use of the potential of modern digital facilities software; difficulty in coping with new software and working with it.

* Order of the Ministry of Labour and Social Protection of the Russian Federation as of 18.10.2013 No. 544n “On approval of the professional standard “Pedagogue (pedagogical activity in pre-school, primary general, basic general, secondary general education) (educator, teacher)”.

In the authors' opinion, the following strategic directions of professional training should underlie the solution of the problem of computer science teachers' digital competence formation: 1) academic modelling of personal digital learning environment for schoolchildren while studying under higher education teacher training programmes, at practical training and professional improvement courses; 2) professional development of pedagogues in terms of realisation of teaching process in a digital learning environment; 3) sharing positive and negative pedagogical experience in the digital education environment; 4) use of digital technologies by the teacher in professional and daily activities for the solution of specific tasks (practice-oriented assignments).

The systematisation of most demanded and most frequently implemented pedagogue's activities in the digital learning environment allowed the authors to develop a number of recommended versions of academic assignments which demonstrate the ways to efficiently integrate the digital tools and web services into the educational process in the form of tasks for future computer science teachers. The typical assignments for the abovementioned activity types can be offered during the professional teacher training in the higher- or further professional education system, for the disciplines "Modern information and communication technologies in education", "Technical and audiovisual means of education", "Computer science teaching methodology" and others.

Below are examples of practice-oriented assignments aimed at the formation of digital competence of computer science teachers in correlation with the core areas of learners' digital literacy.

The present study initiates a new conceptual framework of the teacher's digital competence coupled with the learners' digital literacy.

1. Learners' digital literacy: software and hardware

► The group of general digital competencies:

- 1) To install some applied software or application (e.g. Sberbank online application, photo editor, video editor), to update the digital device software.
- 2) To customise application settings on a digital device (e.g. security settings, protection of personal information, setting permissions for an application, etc.).
- 3) To use cloud technology to store and share files.
- 4) To remove ads in the browser (install a browser ad blocker).

► The group of general pedagogical digital competencies:

- 1) To organise course management in the learning management system (LMS).
- 2) To work in some information system (e-journal, educational organisation website, etc.).
- 3) To use cloud technology to collaborate on documents.
- 4) To encode a link to the website of an educational organisation using QR code for obtaining up-to-date information on some upcoming school extracurricular activity (e.g. with the help of QR Coder service).

► The group of specialist pedagogical digital competencies:

- 1) To select a suitable programme, download and install due software on a computer designed to teach the learners how to create computer game characters in 3D model format.
- 2) To do coding in a programming language. To use a programming language for creation of some educational content.

3) To use some special and universal software applications for creation of some educational content (word processors and spreadsheets, software for creating electronic presentations, graphic editors, database management systems, mathematical software packages, software tools for working with multimedia information).

4) To create a chatbot to actualise information for school learners' parents via WhatsApp (e.g. using BotVsem builder).

5) To change the settings of any software, including the operational system or security software.

2. Learners' digital literacy: informational competence

► The group of general digital competencies:

1) To make search and filtration of data, information and digital content on some topic of an academic discipline.

2) To find up-to-date information on school supplies or digital content development services.

3) To obtain sought knowledge or background information in a free form using online encyclopaedias and other electronic information resources.

4) To evaluate the digital content by comparing data from different information sources.

5) To find information about cultural sites and events.

6) To demonstrate the ways of acquiring information (intellectual experience, search of information for learning (work), reading online newspapers, magazines, e-books on assigned subjects).

► The group of general pedagogical digital competencies:

1) To make a collection of digital learning resources with a view to enrich the learners' digital literacy.

2) To create a digital information resource (website, blog, telegram channel, group in social media).

3) To demonstrate the techniques for acquiring relevant information needed for professional activity (e.g. current statutory deeds in the sphere of general education, reading online news feeds).

► The group of specialist pedagogical digital competencies:

1) To organise broadcasting of a school event in the Internet (e.g. YouTube channel, Discord platform).

2) To use digital platforms for a variety of educational assignments.

3. Learners' digital literacy: communication and collaboration

► The group of general digital competencies:

1) To organise information exchange in a digital environment (e.g. using a social network, messenger, etc.).

2) To install a communication app on the computer or mobile device (e.g. download Skype, Telegram, call via Skype, subscribe to a channel of interest in Telegram, send an audio or video message to someone via Telegram, etc.).

3) To find an article of interest in the Internet and share a link to it with the colleagues or trainees via any social networking site known to you.

4) To create your own social media page and manage your account (e.g. download the

Instagram app on your phone and register your account there, update your photo, write a post with a hashtag #digitalliteracy, etc.).

5) To schedule and deliver an online lesson using video conferencing systems.

6) To record a webinar and edit it.

7) To prepare a video file for the Internet (for YouTube channel).

8) To insert media files into your presentation.

9) To create a video lecture, record a demonstration of an exercise from the screen.

10) To create and revise a document – a school text document, table, methodological guidelines, lesson checklist, distance learning material, etc.

► The group of general pedagogical digital competencies:

1) To organise learners' communication workspace (blogs, social media, cloud technology).

2) To use a social network for sharing useful educational information, organising meetings in the online format.

3) To use a messenger for sharing textual messages, textual files, pictures, videos, to hold voice and video conferences with the use of messengers (e.g. Viber, WhatsApp, Facebook, etc.).

4) Using a messenger, to organise a group chat with the learners' parents and the form master in order to address some issues requiring collective decision making.

► The group of specialist pedagogical digital competencies:

1) To organise a workspace for the learners' interaction in project activities (Discord, Trello).

2) To prepare a workspace for the learners' creative collaboration (wiki pages, encyclopaedias, online publications, playcasts, etc.)

3) To arrange a workspace for the learners' entertainment (online games, search for a variety of photographic, film and video materials).

4. Digital literacy of learners: creation of digital content

► The group of general digital competencies:

1) To create a video, audio, photo image and post it online.

2) To write a blog post or a social media post.

3) To make a selection of useful educational resources (e.g. Integrated collection of digital educational resources (<http://school-collection.edu.ru>), Single access window to educational resources (<http://window.edu.ru>), Catalogue of internet educational resources for basic general and secondary general education (<http://edu-top.ru/katalog>), etc.).

► The group of general pedagogical digital competencies:

1) To organise remote consulting for the learners, to organise interaction between the learner and the tutor in the form of prepared video conference.

2) To create own digital didactic materials or adapt the existing ones for specific learning objectives.

3) To create a terminological vocabulary on a particular topic of the school computer science course in the form of a website (e.g. by the means of Google).

4) To create a mind map for systematising the mastered educational material by subject/unit.

5) To prepare some materials for a quiz (based on the Kahoot! service).

6) To prepare learning assignments for a computer science lesson using gamification elements (crossword puzzles, picture puzzles, etc.) for due assimilation of the learning material.

7) To prepare an interactive geographical map for a history lesson.

8) To develop a timeline illustrating the main stages of computer science development.

9) To design a lesson scenario using digital learning resources, incorporating online course components (e.g., using YaClass, Reshu EGE (unified national examination), MES (Moscow Electronic School), NES (Russian Electronic School), etc.).

10) To prepare online interactive presentation (e.g. using Prezi or Mentimeter service).

11) To prepare an electronic test for knowledge control or an online survey, learners' questioning tools (e.g. using Online Test Pad designer, Google Forms, etc.).

► The group of specialist pedagogical digital competencies:

1) To develop an interactive simulator for a particular topic within the school computer science course (e.g. by means of ThingLink online service) based on creation of interactive images.

2) To develop a scenario for a lesson to demonstrate the resource of artificial intelligence in solving practical assignments (for instance, processing a photo image, creating a music track or an original picture with the help of services involving the elements of artificial intelligence).

3) To prepare an electronic reference material for computer science learning in the form of a 3D page-turning brochure (e.g. based on the constructor Calameo).

4) To prepare an electronic interactive workbook based on interactive worksheets (LiveWorkSheets).

5) To prepare a podcast with action algorithm recording and screen demonstration (by example of demonstration of a programming problem solution) (for instance, using Camtasia Studio or Movavi software) or create a video lesson on a topic of the school computer science course (for instance, using Zoom).

6) To organise the learners' work in creating infographics within a section of the school computer science course for revising, systematisation and generalisation of the training material (for instance, using Piktochart, Canva and other services).

7) To create and/or use an open online course (for instance, using Stepik design tool).

8) To prepare teaching materials for learners' project activities aimed at creating a 3D model (e.g. using Blender 3D).

9) To prepare teaching materials using a specialised mathematical package or online service (e.g., Geogebra).

10) To organise real-time voting in the classroom (e.g., using Mentimeter).

11) To prepare interactive assignments for the lesson (e.g. using Flippity).

12) To develop a 3D model for a lesson in any graphic vector editor or CAD/CAM system (e.g. CorelDraw, AutoCad, KOMPAS 3D, etc.).

5. Learners' digital literacy: information security

► The group of general digital competencies:

1) To make security settings for a personal digital device (e.g. smartphone, tablet, laptop).

2) To restrict learners' access to digital resources depending on the situation (forbidden digital content, fake news, etc.).

► The group of general pedagogical digital competencies:

- 1) To ensure confidentiality of the learners' test results data.
- 2) To prepare training materials using digital content based on the Creative Commons licence, excluding copyright infringement.
- 3) To develop a case study discussing the behaviour in a situation of identity data theft or fraud.
- 4) To develop a case that requires a learner to take a decision in a situation that threatens the learner's information security (e.g. the learner's cyberbullying in a social network).
- 5) To select high-quality educational video content using YouTube educational channels.

► The group of specialist pedagogical digital competencies:

- 1) To demonstrate the use of various security programmes for protection of gadgets, as well as techniques for secure use of the Internet (passwords, antiviral programmes), adherence to personal data protection principles.
- 2) To present assignments demonstrating the formation of learners' awareness of positive and negative impact of digital technologies on human health and the environment.

6. Learners' digital literacy: problem solving

► The group of general digital competencies:

- 1) To choose a due platform in order to share the results of the school computer science course for a particular topic with the peers, or to take part in a professional competition.
- 2) To make a critical selection of digital technologies appropriate for the learning needs and lesson objectives.
- 3) To find relevant information on professional development courses for teachers in the field of digitalisation of education (e.g., using the Federal register of advanced professional pedagogical education programmes, <https://dppo.apkpro.ru>), to select an appropriate programme for professional self-development and get familiarised with this programme.
- 4) To make a financial transaction using an online shop.
- 5) To register on the Gosuslugi portal (government services) and get a service through the portal instruments.
- 6) To evaluate the quality of digital learning resources, to plan their use in the classroom in accordance with the educational objectives.

► The group of general pedagogical digital competencies:

- 1) To monitor the learners' progress and attendance using the electronic gradebook and electronic homework diary, to post grades, to carry out topic-based planning, to take record of home assignments, to schedule the timetable.
- 2) To prepare a workspace for recording brainstorming results (XMind, Coggle, Mind42, Mindmeister, etc.), whiteboards for collaborative work (e.g. Miro, Padlet, Popplet, iDoo, etc.).
- 3) To develop an electronic team-stream portfolio (e.g. by means of online services Canva, uPortfolio, 4portfolio.ru, Portfolio of Business!).
- 4) To apply for a professional improvement course in a distance learning format.
- 5) To prepare markers for the use of augmented reality elements in a biology class, using a mobile app, when mastering a topic that requires detailed visualisation of characteristics of some explored object (e.g. based on Halo AR – 3D Creator & Scanner).
- 6) To get registered with a professional teacher network (e.g. pedsovet.su (teachers

council) and to publish your original material.

7) To use the tools for design of pedagogical activities, visualisation of lesson stages (for instance, using SessionLab service).

8) To organise the learners' joint work over creation of an animated film on assigned subject (for instance, using the Renderforest online service).

9) To prepare a workspace for joint work of the teacher and the learners using the online whiteboard (e.g. Miro, iDoo, etc.).

10) To organise a workspace for implementation of the learning process, including for the purpose of posting theoretical learning materials and assignments, grading, organisation of collaborative work (e.g., using Google Classroom, Russian platform Eduardo, Russian educational platform Stepik – designer of free open online courses and lessons, etc.).

► The group of specialist pedagogical digital competencies:

1) To use VR technologies for teaching learners to take decisions in different situations.

2) To handle the task of online purchase of computer science learning equipment or visual learning aids from an online shop.

7. Learners' digital literacy: career competencies

► The group of general digital competencies:

1) To define the big data concept. To describe the technologies for big data handling and storing.

2) To describe the main approaches in machine learning.

► The group of general pedagogical digital competencies:

1) To use LMS platforms in assessment of analytics tools.

2) To use the results of learner digital footprint approach for the analysis of learners' performance and development of individual educational technologies.

3) To present visually the big data analytics results.

► The group of specialist pedagogical digital competencies:

1) To use the big data analytics methods (e.g. MapReduce, Hadoop, NoSQL, etc.) in designing electronic educational resources, in development of customised curricula and individual educational trajectories, in automation and extension of the learning process analysis.

2) To organise the learners' project activities in development of graphic design environment, to create 3D characters of computer games, etc.

3) To prepare teaching materials for inclusion of learners in the activities aimed to familiarise them with mobile application development technology.

4) To organise extracurricular activities demonstrating the use of the Internet of Things in practice.

The list of assignments proposed in the study can be continued, promptly supplemented and updated in accordance with the subsequent development of digital technologies. It should be noted that such exercises not only provide for the formation of the future teacher's individual digital competencies, but also represent a basis for inculcation of the idea of systemic (multidimensional) application of digital tools in the educational process and daily activities, contribute to the pedagogue's digital competence in all areas of learners' digital literacy, form experience of efficient use of digital technologies in professional

activities, teacher's readiness to develop schoolchildren's digital proficiency, realise the interdisciplinary approach in teaching.

Discussion

The formation of digital competence of computer science teacher has become today one of the most important targets in the system designed to train skilled pedagogues for the digital school. The system of practice-oriented assignments for a computer science teacher, as proposed in this study, is aimed at formation of his/her digital competence. The previous research into formation of teachers' digital competence proposed certain solutions regarding the ways for achieving thereof; among them is a proposal to develop psychological and pedagogical support programmes for teachers to the extent of growth of their ICT competence, for successful transition from the traditional teaching to the digital-environment pedagogical engineering zone [24]; a proposal to use the gender approach in assessing the teachers' preferences in the use of digital technologies [25]; a proposal of innovative approach to pedagogues' professional development in the aspect of formation of their digital competence (for instance, virtual coaching) [26], etc. In this regard, the peculiarity of the approach outlined in our study is orientation at preparing a teacher for the development of learners' digital proficiency, ensuring the pedagogue's readiness to become a digital tutor of schoolchildren in mastering digital skills in all areas of digital literacy. At the same time, digital competence involves teachers' creative activities in digital space. This concerns mastering new ways of using online tools and environments, creating new knowledge with the help of digital technologies, using analytical abilities and skills in assessment of digital content, digital instruments and services, acquiring the skills of finding and using reliable information sources, realising the potential of digital technologies for self-organisation and self-development, extending pedagogical experience and professional mastery, creating a digital portfolio of professional achievements [27], demonstrating the best practices of digital education, exercising digital civil rights and getting online services, organising professional cooperation and joint activities in digital environment. Digital competence and digital literacy represent the basis for sustainable development of the digital society, social cohesion [28], improved community living conditions, productive collaboration, professional and personal self-realisation. These characteristics, underlying the teaching and learning process in the workplace, at school and in the society at large, are increasingly recognised as necessary. The properly trained teaching community with necessary digital competencies is able to respond immediately and positively to any challenges and achieve optimal results in doing so.

The digital competency formation assignments for teachers are structured by digital proficiency domains and by groups of general, general pedagogical and specialist pedagogical digital competencies. This structuring of digital competence, in our view, is a basis for monitoring the state of its establishment at a certain level of its development (basic level, digital use, digital transformation).

The obtained results can be used in development of the content of the communicative/digital module of pedagogical baccalaureate programmes and specifically for the selection of content of the discipline "Digital education technologies", as well as in the development of supplementary professional education programmes (advanced training courses) in the fields "Formation of basics of teacher's digital competence", "Digital education environment as a

tool for development of teacher's digital competence", "Digital pedagogical technologies as a means of formation of learners' digital literacy". The development of professional training programmes on these subjects for teachers seems promising, so that they could efficiently introduce digital technologies in class and bring the quality of general education to a new level of development in the conditions of digital transformation. The advanced training programmes will make it possible to cover the priorities and problems of digitalisation of education, the approaches to creating a digital learning environment at school, to demonstrate the potential of digital platforms and digital technologies in the educational process and in daily activities, develop customised learning technologies in digital space, shape the learners' digital literacy; to use due methods and techniques for implementing the training process in a digital learning environment, to apply digital tools and services for the solution of specific pedagogical tasks.

Conclusion

It should be noted that schools have to go through a labour-intensive journey to prepare the learners for well-established digital skills in the rapidly changing technological world. This is especially true for instructing learners in the skills and strategies for efficient use of digital devices for practical activities, reading and search of digital content in the Internet, creative cooperation involving digital technologies, cybersecurity, use of digital technologies for solving a variety of problems, formation of learners' career competencies that are important in the digital world. Addressing the above challenges involves the formation of learners' digital proficiency in order to enable them to have full access to education, employment and realisation of social opportunities in the digital reality. The teacher of computer science has an important role in the formation of learners' digital literacy – his/her digital competence, readiness for efficient and appropriate use of digital technologies in the solution of pedagogical assignments, including in the formation of learners' digital expertise. At the same time, teachers need ongoing support for enhancing their digital skills in line with the digitalisation development trend. This means that schools and teacher training institutions should enable all pedagogues to acquire digital skills and new knowledge about digital technologies for efficient integration of digital technologies into their everyday practice. Moreover, teachers should continuously work on advancement of their skills and self-development using available sources of information and methodological support from the outside as well as necessary online resources.

A digitally competent teacher will be able to make a conscious and appropriate choice of digital tools and services for achievement of the set instructional, developmental and educational goals; will be able to motivate the learners, provide more apprehensible treatment of training materials, promote the learners' digital literacy, their autonomy as well as other learning outcomes important in the digital society.

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