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RESEARCH ARTICLE

Model of formation of digital competences in implementing higher education programs

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Abstract
Objectives. The paper presents and analyzes a model for the formation and evaluation of digital competencies in students. The model is aimed at the implementation of higher education programs for training specialists not directly working in IT, but whose activities are directly related to using ready-made digital products. Digital competences imply an ability to confidently, effectively, and safely select and apply information and communication technologies in various life practices including researching and critically analyzing information, using digital devices and accessing social network functionality, conducting financial and trading transactions, as well as creating digital content. The formation of such digital competences is one of the results of completing higher education programs.
Methods. The study is based on a model of digital competence formation having the following four interconnected stages: basic digital competences; personal competences (soft skills); professional digital competences; digital culture.
Results. The presented general model for the formation and assessment of student digital competences in higher education programs consists of four interrelated steps, each integral to the process of formation and assessment of the student digital competences, none of which can be excluded without the risk of failing to achieving the specified goals.
Conclusions. The model developed in the paper is based on the existing extensive regulatory framework, as well as existing domestic and foreign practices. Relying on expert community opinion (employers, primarily), it accounts for sector- and region-specific features of universities along with specifics of training areas, as well as comprising a list of optimal organizational and methodological conditions for formation of digital competency.

Keywords: digital competence, digital literacy, digital continuum, model of digital competences, assessment, professional competences, digital culture, information and communication technologies

НАУЧНАЯ СТАТЬЯ

Модель формирования цифровых компетенций при реализации программ высшего образования

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Резюме

Цели. Целью работы является анализ модели формирования и оценки цифровых компетенций обучающихся при реализации программ высшего образования, ориентированной на подготовку специалистов, не относящихся непосредственно к ИТ-сфере, но деятельность которых напрямую будет связана с применением цифровых продуктов. Под цифровыми компетенциями индивида следует понимать его способность уверенно, эффективно и безопасно выбирать и применять в различных жизненных практиках информационно-коммуникационные технологии (ИКТ), в т.ч. осуществлять поиск и критическое осмысление информации; использовать цифровые устройства, функционал социальных сетей; выполнять в онлайн-режиме финансовые и торговые операции; производить цифровой контент. Формирование цифровых компетенций у обучающихся – один из результатов освоения программ высшего образования.

Методы. Использована модель формирования цифровых компетенций, включающая четыре связанных между собой этапа: базовые цифровые компетенции, личностные компетенции (soft skills), профессиональные цифровые компетенции, цифровая культура.

Результаты. Разработана базовая (общая) модель формирования и оценки цифровых компетенций обучающихся при реализации программ высшего образования. Она состоит из четырех взаимосвязанных ступеней, каждая из которых является неотъемлемой частью процесса формирования и оценки цифровых компетенций обучающегося и не может быть исключена без риска недостижения поставленных задач.

Выводы. Разработанная авторами модель основана на обширной нормативно-правовой базе, существующих отечественных и зарубежных практиках; опирается на мнение экспертного сообщества (прежде всего, работодателей); учитывает отраслевые и региональные особенности вуза, специфику направлений подготовки; содержит перечень оптимальных организационно-методических условий формирования цифровых компетенций.

Ключевые слова: цифровая компетентность, цифровая грамотность, цифровой континуум, модель цифровых компетенций, ассесмент, профессиональные компетенции, цифровая культура, информационно-коммуникационные технологии

GLOSSARY

Digitalization is the process of spreading and implementing digital technologies in various spheres of society: economy, culture, education, etc.

Digital competence is the ability to confidently, effectively, critically, and safely select and apply information and communication technologies in different spheres of life (information environment, communications, consumption, and the technosphere) based on continuous competence mastering (knowledge, skills, motivation, and responsibility), as well as the readiness to participate in such activities.

Digital continuum is the set of tools, techniques, and forms of education integrating the interaction of all educational process participants both within and outside the educational program, based on the use of digital technologies necessary for forming skills and competences demanded by the current labor market.

INTRODUCTION

Digital competences may be represented as the ability to apply information and communication technologies (ICT) in various spheres of life, namely, in creating and distributing digital content, as well as solving complex problems in the digital environment (e.g., project and business tasks). The rapid development of digital technologies necessitates the continuous updating and expansion of digital competences of citizens in order to effectively build a digital society.

It seems reasonable to clarify the above definition of "digital competence." In studies on this topic, various approaches to defining digital competence have been analyzed[1, 2] [1]. For example, in the analytical report for 2012 devoted to analyzing the identification and transformation of digital competences, A. Ferrari has proposed the following definition: "*Digital competence is the set of knowledge, skills, attitudes, abilities, strategies, and awareness that is required when using ICT and digital media to perform tasks, solve problems, communicate, manage information, behave in an ethical and responsible way, collaborate, create and share content and knowledge for work, leisure, participation, learning, socializing, empowerment, and consumerism*" [2].

According to Ya.V. Dmitrieva and I.A. Alyabin [3], digital competence entails a set of several digital skills and acquired knowledge necessary for continuous

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[1] Country digital readiness: Research to determine a country's digital readiness and key interventions. https://www.cisco.com/c/dam/assets/csr/pdf/Country-Digital-Readiness-White-Paper-US.pdf. Accessed November 15, 2021.

[2] Djumalieva J., Sleeman C. Which digital skills do you really need? 2018. Nesta. The Innovation Foundation. https://media.nesta.org.uk/documents/Which_digital_skills_do_you_really_need.pdf. Accessed November 15, 2021.

application in professional activities. Since digital competence simultaneously "encompasses information management, collaboration, communication and sharing, content and knowledge creation, ethics and responsibility, assessment and problem solving, and technical operations," it represents the sum of all digital competences a person possesses.

In the study carried out by I.A. Volkova and V.S. Petrova [4], it is assumed that digital competences are the key to developing the digital economy not only as an IT platform, but also as a digital product. In their view, the following digitalization stages may be conventionally distinguished: 1) digital inclusion; 2) digital law; 3) schools; 4) further education; 5) higher education; and 6) digital apprenticeship. Accordingly, within each of the listed stages, five areas are identified through which digital competence should pass: 1) digital financial literacy; 2) digital information literacy; 3) digital capture and exchange of cultural artifacts; 4) remote work; and 5) business data and systems integration.

The definition of digital competence proposed by G.U. Soldatova covers a wide range of problems and practices related to using ICT in modern society: "*the ability of a person to confidently, effectively, critically and safely select and apply information and communication technologies in various spheres of life* (*information environment, communication, consumption, and technosphere*) *based on continuous mastering the competences* (*knowledge, skills, motivation, and responsibility*)*, as well as his or her readiness for such activity focusing on the efficient result*" [5].

In the digital competence structure proposed by Soldatova, knowledge, abilities, skills, motivation, and responsibility are included. An important component of the last element is safety. Each of these components is implemented to a greater or lesser extent in various spheres of activity in the Internet environment. Four types of digital competence are identified: *media competence* aimed at finding, comprehending, critically understanding digital information, and creating information objects using digital resources (text, image, and audio/visual); *communicative competence* necessary for various forms of communication (e-mail, chat rooms, blogs, forums, social networks, etc.); *technical competence* forming responsible use of hardware and software tools for solving various problems; and *consumer competence* based on solving everyday tasks and life situations using digital devices and the Internet.

The conceptual framework for defining digital competence based on studying cognitive and metacognitive dimensions related to technologies is proposed by A. Kalvani et al., called the digital competence framework [6]. The authors find digital competence to consist in the convergence of three basic dimensions: technological, cognitive, and ethical. The

technological dimension involves the ability to create technologies, the cognitive dimension demonstrates the ability to critically evaluate digital text and data, while the ethical dimension entails the competency of consciously interacting effectively with others using various technological platforms.

In many cases, the study of digital competences is based on using the concept of professional competences. For example, the KSAO concept is based on knowledge (K), skills (S), abilities (A), and other characteristics (O) required by professionals for doing their job effectively. The technological acceptance model describes the extent to which citizens have faith in their technological abilities (competences) and how they use government e-services.

The study of digital competence can also be based on sociocognitive and planned behavior theories. According to such psychological theories, an understanding and evaluation of digital competence is based on the concept of self-efficacy. The underlying knowledge providing insight into the cognitive determinants of behavior includes a person's beliefs about his or her ability to be successful; here, the power of control may function as an indicator for predicting a person's intentions [7].

The above suggests that digital competences can be understood as a person's ability to confidently, effectively, and safely select and apply ICT as part of various life practices. These include searching and critically evaluating information; using digital devices and social networking functionalities; conducting online financial and trade transactions; and producing digital content. Such abilities are based on the relevant knowledge, skills, and abilities in the field of digital development acquired in the process of mastering various educational trajectories (secondary, higher, and additional professional education). At the same time, the formation and evaluation of digital competences of higher education (HE) students as specified by the relevant federal state educational standards (FSES) should be reflected in implementing HE programs [8].

METHODS

The developed model for forming digital competences is based on the set of methodological materials (developed by leading educational organizations in the country) presenting various digital competence models (DCMs). Each of the analyzed DCMs forms the appropriate focus and content of actions for implementing it in the educational strategy of the university.

The analysis of domestic DCMs allows suggesting that the professional and personal competences supplemented with variances of basic competences and digital culture (digital ethics) are most often identified by their developers relying on the voluminous body of foreign literature covering this issue. When describing the key characteristics of professional and personal competences, foreign and Russian researchers adhere to general methods and principles. For example, the competence model proposed by researchers from the Russian Presidential Academy of National Economy and Public Administration includes four interrelated blocks: basic digital competences, personal competences, professional competences, and digital culture [9].

In the model, personal competences (soft skills) are represented by the following groups of competences:

1) *result orientation*—implying the ability to simulate different development scenarios and thereby achieve digital development goals in the most effective way);

2) *customer centricity*—implying the ability to build trusting long-term relationships between all interested parties);

3) *communicativeness*—implying selecting the most effective communication strategy and tactics;

4) *emotional intelligence*—implying creating the favorable psychological and emotional climate for teamwork;

5) *creativity*—implying the ability to find a way out of difficult situations using non-standard approaches;

6) *criticality*—implying formation of different scenarios for achieving strategic goals as well as the ability to create concepts and versions of strategies for different time periods.

When all indicators cited by the researchers have been achieved, a person is enabled to successfully participate in implementing a digital transformation strategy and participated in digital development projects.

In our view, it may be also reasonable to consider the block of professional competences (hard skills) in the field of digital development whose formation determines the management of processes, projects, products of digital transformation, and regular solving difficult professional tasks in the digital environment. Six key professional competences are presented in the model. Each group may be characterized by specifying the following most relevant indicators:

1) *digital development management*—implying knowledge, skills and abilities to apply the strategic management tools, techniques, and approaches in digital development management;

2) *organizational culture development*—implying knowledge, skills, and abilities to apply tools and techniques of organizational culture formation and broadcasting as well as organizational change management techniques;

3) *management tools*—implying knowledge, skills, and abilities to apply tools and techniques of the project approach (basics of project management; project management system at the state and organization level; projects, project programs, and project portfolios); and project life cycle management processes (initiation, preparation, implementation, monitoring, control, and completion);

4) *data management and use*—implying knowledge, skills, and abilities to apply data-driven decision-making (DDDM) technologies (DDDM culture and ethics; DDDM integration into business processes of the organization; automatic decision-making systems including artificial intelligence systems; ensuring data security; and data lifecycle management techniques (data model design, data lifecycle stages);

5) *application of digital technologies*—implying knowledge, skills, and abilities to apply end-to-end (E2E) technologies (new production technologies, neurotechnologies and artificial intelligence, wireless communication technologies, components of robotics and sensorics, quantum technologies, distributed registry systems, and virtual and augmented reality technologies); means and methods of information security and cybersecurity;

6) *IT infrastructure development*—implying knowledge, skills, and abilities in the field of technical documentation regulating functioning of information systems and IT products.

In the model, a digital culture comprises the system of values, attitudes, and norms and rules of behavior supported and broadcasted by the digital transformation team.

The competence model proposed by the NAFI multidisciplinary analytical center[3] is no less significant for the study. It identifies the following competences: 1) information literacy (searching for information on various resources and assessing its usefulness and harm); 2) computer literacy (ease of use of any digital devices); 3) media literacy (searching for and filtering news from various sources); 4) communication literacy (use of digital communication, i.e., social networks and messengers); and 5) attitudes towards technological innovation (readiness to quickly adapt to new technologies).

Here, the model proposed by E.A. Khodyreva from Innopolis University is worth mentioning. In the report "Assessing digital competences in educational programs" presented at the IV Annual Meeting of Leaders in the Field of Education, Knowledge, and Digitalization Management held in Sochi (October 2021),

she specified the following main DCM blocks: *basic digital competences* (digital skills); *professional competences in digital development including industry-specific ones* (hard skills); *personal competences in digital development* (soft skills). Universal professional competences include organization of project activities, business processes, customer centricity, data culture, application of digital products in industry (professional activity), presentation (visualization), delivery of information using data, and prototyping. Personal competences include focusing on results, leadership, communication, critical thinking, self-development, resource management, strategic thinking, creative thinking, and teamwork. In the report, information literacy, communication literacy, digital content creation, digital security, and problem-solving skills in the digital environment are referred to as basic digital competences.

The theoretical and methodological DCM analysis carried out in the present study revealed a significant segment of common characteristics: universality (the ability to update the model for organizations, departments, and teams of any type and economic sector); scalability (the ability to adjust the set of competences to corporate characteristics and industry focus); the presence of block structure (attention is paid not only to competences, but also to the values underlying digital transformation); the ability to create both own models and separate products (e.g., personal trajectories of professional development in digital transformation, personal digital profiles of digital transformation participants, etc.) based on it.

It is reasonable to apply the principles and methods embedded in DCMs, which have been developed by Russian educational organizations for creating a model of digital competence formation (DCF), to identify a step-by-step process integrated into university educational trajectories. At the present stage, the issue of applying the DCF model in implementing the HE program is yet to be comprehensively studied due to the relevant practices being in the process of formation. This gap may be filled by the DCF model proposed in the paper for areas not related to the ICT professional sphere.

RESULTS

The basic (general) model of formation and assessment of student digital competences in implementing HE programs developed in the paper consists of four interrelated stages, none of which can be excluded without the risk of failing to achieving the defined goals due to being integral to the process of formation and assessment of the digital competences

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[3] Digital Literacy of Russians: A 2020 study. https://nafi.ru/analytics/tsifrovaya-gramotnost-rossiyan-issledovanie-2020/. Accessed December 3, 2020 (in Russ.).
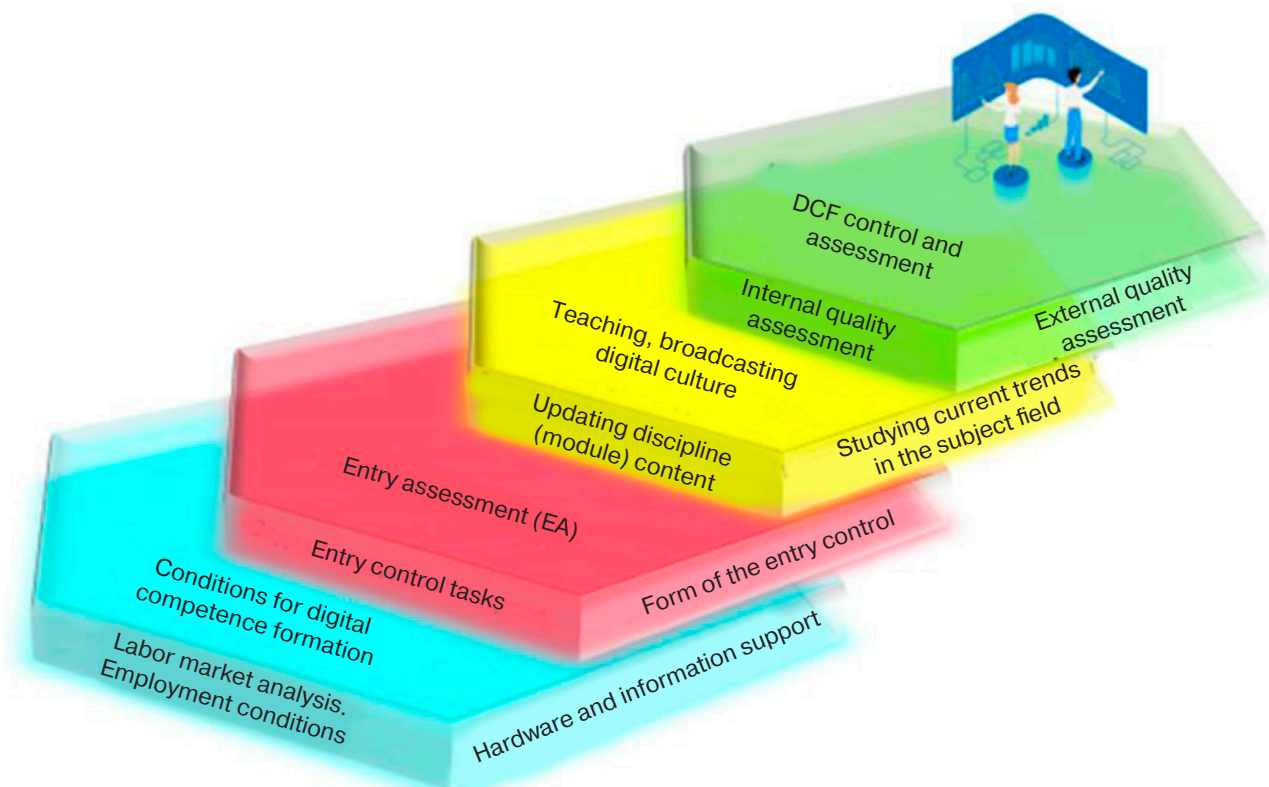
Fig. 1. The basic (general) model of formation and assessment of student digital competences
in implementing HE programs

of students (Fig. 1). The model is focused on training professionals for working in areas not directly related to the ICT field, but whose activities are directly related to applying final digital products.

Implementing the first step of the proposed model being ***the conditions for the formation of digital competences*** is a step-by-step process including monitoring the labor market, creating the digital educational continuum, and staffing the application of digital technologies in the educational process.

In our opinion, it is reasonable to involve published sources containing the results of sociological surveys on requirements of employers, not only for qualifications, but also primarily for the digital skills and competences of professionals according to labor market analysis. A review of the relevant literature[4] [10, 11] concludes that the digital economy requires personnel not just oriented towards the digital environment, but also able to design and create it by themselves, as well as to actively apply all its resources and tools in their professional activity. Of paramount importance here is not the amount of information the person receives but the knowledge and skills for effectively applying and managing it,

including the use of digital devices, communication applications, and networks. According to the data of the HeadHunter[5] and Superjob[6] companies, which represent the leading national online recruitment agencies, today's employer is more interested in transprofessional competences, which allow the professional not only to interact with digital products and solutions, but literally to immerse him/herself inside the virtual content, modeling and developing it.

The second stage of the first step includes the development and formation of the digital educational continuum as a basic component of organizational and methodological support for DCF in implementing HE programs. In the paper, this is defined as the set of tools, techniques, and forms of education integrating the interaction of all educational process participants, both within and outside the educational program, based on the use of digital technologies necessary for forming skills and competences demanded by the current labor market.

The digital continuum implies much more than the electronic information-educational environment due to representing an effective and safe digital environment for students; its components are educational content, university mobile applications, and electronic interaction

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[4] Sorokin D. Participation of the Russian Federation subjects in the implementation of the "Personnel for the Digital Economy" federal project. https://d-russia.ru/wp-content/uploads/2019/09/sorokin.pdf. Accessed December 8, 2021 (in Russ.).

[5] https://hh.ru/. Accessed April 6, 2022 (in Russ.).
[6] https://www.superjob.ru/. Accessed April 6, 2022 (in Russ.).

channels. It is reasonable to assert the creation of a fully digital environment wherein the student is not only the user but also the full participant modeling it, for example, for his/her personal educational trajectories. The digital continuum formation accelerates immersion in the environment of modern digital interactions similar to the environment the graduate finds him/herself after graduation.

An analysis of employer requirements concerning digital skills and competences of graduates identifies a set of hardware and software tools required for setting up the digital continuum[7] [12]. In terms of free software, *1C:Enterprise 8.3*[8] and *Kompas-3D LT*[9] may be recommended, while *EOS*[10], *T-FLEX CAD*[11], *Astra Linux*[12], and *QForm*[13] are examples of licensed software for implementing HE programs. Certainly, this list is not exhaustive. The list of software with regard for the required digital skills in the professional field should be independently determined by the educational organization.

Using software products requires appropriate hardware. The RTU MIREA long-term strategy for increasing the hardware base of the educational process proves that computer classrooms should be equipped with modern multimedia equipment including the projection screen, multimedia projector, plasma panel, camcorder, computers, video conferencing equipment, and audio equipment.

The formation of a digital continuum also implies using modern professional databases, information reference systems, and electronic library systems relevant for corresponding HE programs. It would be advisable to form such a list in consultation with representatives of organizations providing the base for practical training, as well as with potential employers from state organizations and commercial structures.

We believe that the number of current professional databases and information reference systems should include "1C:Enterprise for educational institutions via the Internet,"[14] CLE International[15], COMSOL

Multiphysics®[16] software for multiphysical modeling, eLIBRARY.RU[17], etc. Among electronic library systems can be identified, for example, Urait[18], IPR Books[19], EBS Znanium[20], and University Library Online[21].

Staffing of the educational process being the third stage of the first step implies formation of the teaching staff from among teachers capable of applying ICTs in the educational process and integrating digital literacy with their other professional competences. Obviously, a contemporary university teacher—just like professional in any other field—should strive to develop his/her transprofessional skills focused on immersing in the digital environment and work in it. This would allow the teacher to respond flexibly to the development of new teaching models and maintain their competitiveness in the labor market. The educational organization, in its turn, should develop the systematic approach to training and retraining the teaching staff in the field of digital literacy, digital technologies, products, and tools. Practitioners having digital competences can be helpfully involved in the educational process.

The study allows formulating the following requirements for the teacher concerning mastering necessary digital competences: use of the digital environment for organizing the learning process, search and analysis of information, cybersecurity, digital ethics, information management, communication in the digital environment, and continuous self-education.

Implementing the first step in the proposed model is designing the list of required indicators for digital competences (professional and personal).

The entry assessment, comprising the second stage of the proposed model, determines the basic level of student knowledge towards which the DCF educational process is aimed. The entry control determines the necessary requirements as to the content of disciplines (modules) forming digital competences.

The first stage of the second step includes defining the most complete list of basic digital competences and developing the entry control tasks for identifying DCF level among students. Basic digital competences are the basic level of knowledge and skills for using ICT in professional activities and common life practices. It is assumed to be not lower than the level defined by FSES for secondary education.

The entry control content should fully reflect the subject fields related to digital technologies. Thus, the

[7] A set of materials on digital skills. Geneva, 2018:6–7. https://psihdocs.ru/komplekt-materialov-po-cifrovim-navikam.html. Accessed January 18, 2022 (in Russ.).

[8] https://v8.1c.ru/podderzhka-i-obuchenie/uchebnye-versii/distributiv-1s-predpriyatie-8-3-versiya-dlya-obucheniya-programmirovaniyu/. Accessed April 6, 2022 (in Russ.).

[9] https://kompas.ru/kompas-3d-lt/about/. Accessed April 6, 2022 (in Russ.).

[10] https://eos.ru/. Accessed April 6, 2022 (in Russ.).

[11] https://www.tflexcad.ru/. Accessed April 6, 2022 (in Russ.).

[12] https://astralinux.ru/. Accessed April 6, 2022 (in Russ.).

[13] https://qform3d.ru/. Accessed April 6, 2022 (in Russ.).

[14] https://edu.1cfresh.com. Accessed April 6, 2022 (in Russ.).

[15] https://www.cle-international.com. Accessed April 6, 2022 (in Russ.).

[16] https://www.comsol.ru. Accessed April 6, 2022 (in Russ.).

[17] www.elibrary.ru. Accessed April 6, 2022 (in Russ.).

[18] https://urait.ru/. Accessed April 6, 2022 (in Russ.).

[19] https://www.iprbookshop.ru/. Accessed April 6, 2022 (in Russ.).

[20] https://znanium.com/. Accessed April 6, 2022 (in Russ.).

[21] https://biblioclub.ru/. Accessed April 6, 2022 (in Russ.).

following topics of questions/tasks for determining the basic digital competence level of students may be recommended:

- formation and evolution of information society and information technologies;
- basic terms and concepts of digitalization and digital economy;
- the role of information in the modern world;
- information and digital technologies in the media segment and creative activities;
- digital technologies in communication;
- safety engineering when using office equipment;
- information security;
- ethical behavior in the digital environment;
- selecting digital tools and applications required for solving assigned tasks;
- searching the Internet for information;
- analysis and processing of digital information;
- algorithms and algorithmic models for solving professional tasks;
- data storage and processing;
- text editors;
- electronic spreadsheets;
- databases.

At the second stage of the entry assessment (second step), it is necessary to decide on the format of the entry control and its implementation (test, oral questioning, questionnaire, portfolio, essay, and case study). The
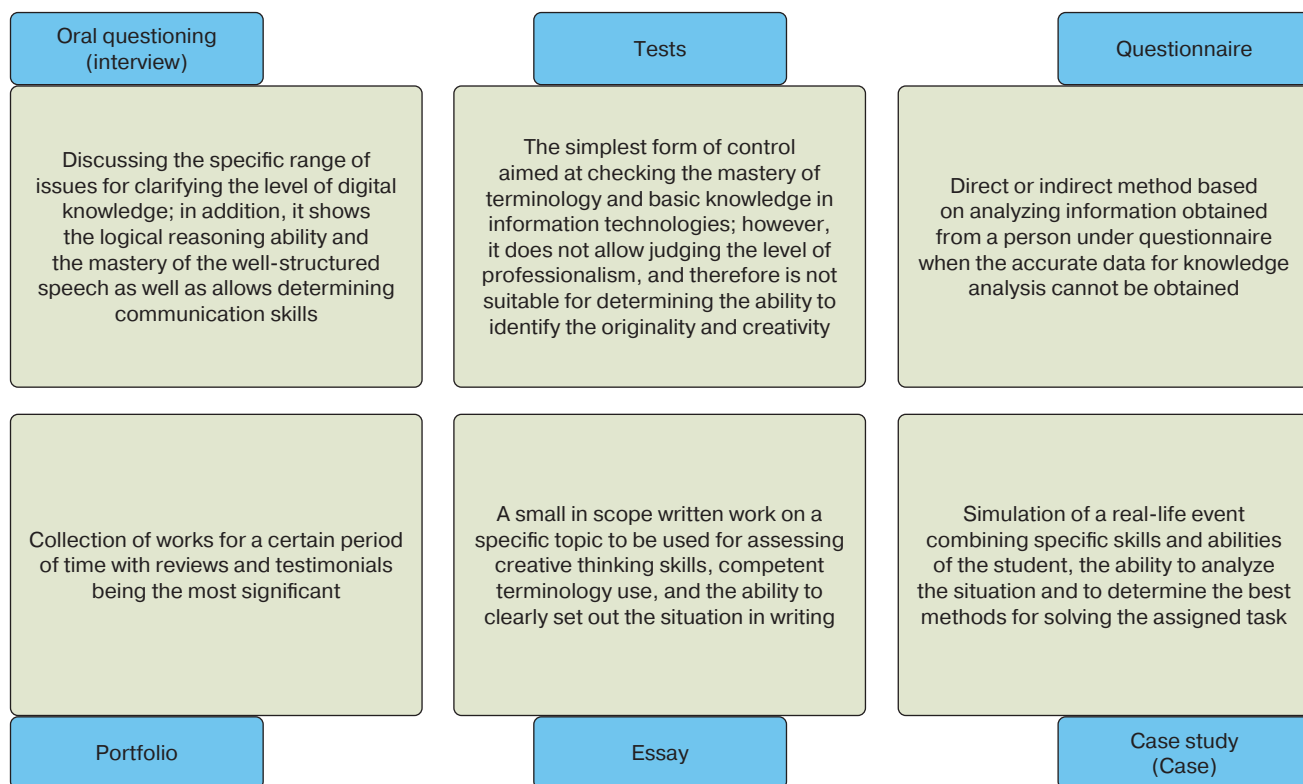
forms of entry control and using the results are shown in Fig. 2.

Due to each format having its own advantages and disadvantages, it seems reasonable to use the combination of various formats. For example, testing may reveal mastery of terminology and the digital knowledge basics while case study or questionnaire reveals their depth.

The third step of the DCF model is focused on teaching and broadcasting digital culture. This step forms the digital competences required for successful professional activity in the digital economy. Its implementation is based on the achievements of the first and second stages. The results are used to determine the updating of educational disciplines (modules) in DCF terms.

The study suggests that indicators of the required DCF level with allowance for the subject field characteristics, available tools for assessing their formation, and current trends in the digital economy should be relied on when updating working programs of disciplines (modules). The unity of pedagogical requirements for each digital competence may be achieved by developing the unified assessment tool for student progress monitoring and midterm attestation in all educational disciplines.

Digital competences are formed throughout the entire period of study. This is achieved through a combination of various factors. They include the

Oral questioning (interview)	Tests	Questionnaire
Discussing the specific range of issues for clarifying the level of digital knowledge; in addition, it shows the logical reasoning ability and the mastery of the well-structured speech as well as allows determining communication skills	The simplest form of control aimed at checking the mastery of terminology and basic knowledge in information technologies; however, it does not allow judging the level of professionalism, and therefore is not suitable for determining the ability to identify the originality and creativity	Direct or indirect method based on analyzing information obtained from a person under questionnaire when the accurate data for knowledge analysis cannot be obtained
Collection of works for a certain period of time with reviews and testimonials being the most significant	A small in scope written work on a specific topic to be used for assessing creative thinking skills, competent terminology use, and the ability to clearly set out the situation in writing	Simulation of a real-life event combining specific skills and abilities of the student, the ability to analyze the situation and to determine the best methods for solving the assigned task
Portfolio	Essay	Case study (Case)

Fig. 2. Forms of entry control and using the results

presence of interdisciplinary links in the educational program and maintaining the continuity of the discipline. Obviously, the required digital competence level can be achieved only by their step-by-step formation at the indicator level for each separate discipline in the presence of interdisciplinary links in the educational program. The significant amount of work in this regard (methodological support, primarily) is carried out by the scientific and methodological council of the university that may involve the potential employer representatives in these activities.

The educational process throughout the updated programs of disciplines (modules) is accompanied by broadcasting digital culture from the digital educational continuum, ensuring harmonious integration of digital competences into the student personal competences. In the process of mastering the educational program, professional digital competences may be transferred into the category of everyday life practices, thus forming the new generation digital personality.

We believe that the student digital competence should be identified among the digital culture key values. In our opinion, it is the readiness for innovative technological challenges that forms the basis for successful digital development and an integral part of the digital culture of future professional having the necessary knowledge and skills, understanding of using ICTs and digital technologies in life and professional activities, as well as respecting digital ethics and safety. Achieving the claimed indicators is the result of the third step aimed at the digital culture formation and broadcasting.

The DCF control and assessment is the fourth step of the proposed model consisting of two stages. The first stage includes the assessment of educational achievements (formation of digital competence indicators) planned for disciplines (modules) and practices within the framework of ongoing and midterm attestation; diagnostics of the DCF level; and final state attestation.

When assessing the achievement of learning outcomes, the study recommends the creation of a register of indicators displaying all DCF indicators of the student.

The student mastery levels are established using appropriate assessment tools; thereby, the educational program should include the set of assessment materials for checking the theoretical and practical knowledge in the field of digital application. In our opinion, an important component of the assessment material system may be cases (problem-situational type of practical tasks requiring comprehensive approach to their solution), since their application is seemed the most effective for solving practical professional tasks requiring implementation of digital competences.

The second stage of the fourth step provides an independent external assessment of the student (future professional) DCF[22] [12]. It includes various implementation formats, namely the following:

- involving potential employers in forming assessment materials; providing the basis for practical training by them; and participation of employer representatives from governmental and non-governmental organizations in the midterm and final state attestation, reviewing the educational program in DCF terms in the professional field;
- systematic questionnaire of employers on their satisfaction with DCF level of graduates conducted by the educational organization (at least once a year). Based on the employer questionnaire results analysis, the educational organization adjusts the educational program;
- questionnaire of graduates (e.g., sending out questionnaires through e-mail) on their professional fulfillment degree in the labor market as well as on the competitiveness and employer demand for digital skills and competences acquired in their training period.

Thus, the educational program may be updated by the educational organization on the basis of the final state attestation results and obtained values for independent assessment of the graduate DCF (professional and personal). Adjusting the educational program (Fig. 3.) is a continuous multi-iterative process.

CONCLUSIONS

Thus, the study concludes by recommending that the basic (general) model for formation and assessment of the student digital competences in implementing HE programs be focused on formation of the fundamentally new personal and professional digital competences. The development of approaches to their formation is determined by new trends in the economy and society development influenced by the rapid spread of digital platforms, ecosystems, E2E technologies, and digital tools. Graduates should acquire the skills, knowledge, and abilities to flexibly adapt to market and employer demands in the digital competence application; easily socialize in the digital society; implement digital projects; use digital tools to identify, access, manage, analyze, assess, and synthesize digital resources; select and apply ICT in everyday life practices and professional activities effectively, critically, and safely.

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[22] Methodological recommendations on the use of digital tools for confirming the results of the assessment of the digital economy competencies. https://old.digitalskills.center/upload/iblock/e0d/e0dd8b36038dee3fc37eceddb9bec13e.pdf?_ga=2.111898692.1115568595.1639414150-1681117855.1639414150. Accessed December 2, 2021 (in Russ.).
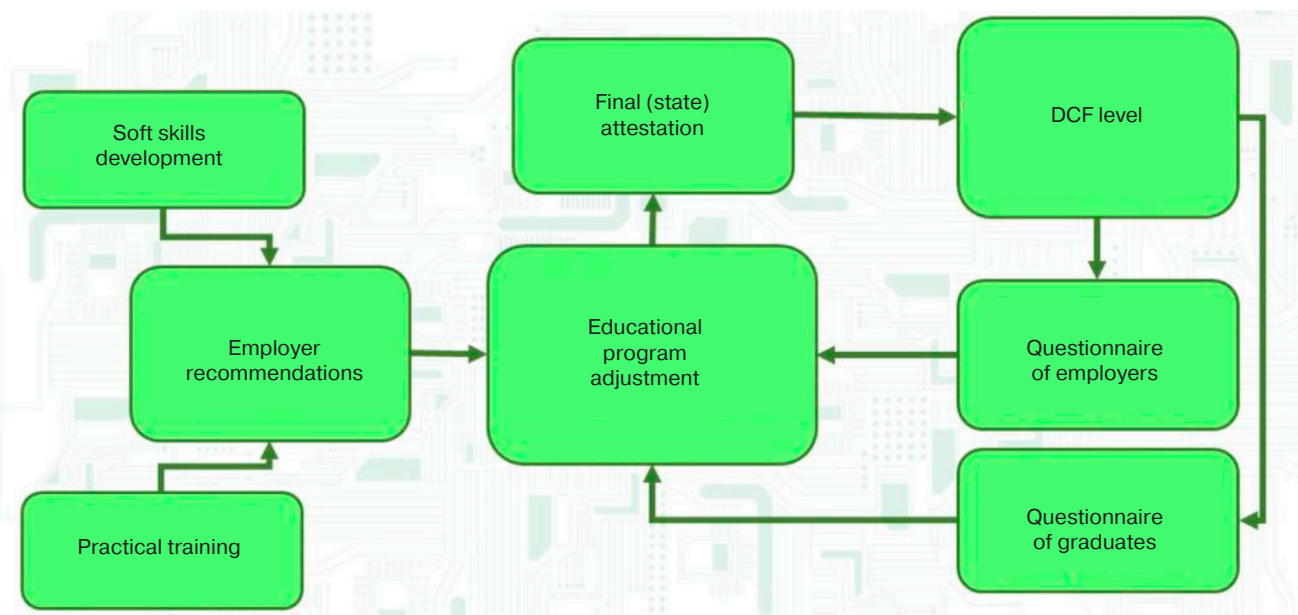
Fig. 3. Educational program adjustment

The presented model is based on the extensive regulatory framework, digital competence models from the leading domestic educational organizations, and the voluminous body of literature revealing the concept of digital competence along with its constituent blocks. It complements and expands the already existing practices of creating, implementing and assessing DCF models in HE programs. The advantages of the model are in terms of its reliance on expert community opinion (employers, primarily), as well as its accounting for sectoral and regional specific features of HE institution, training area specifics, and availability of optimal organizational and methodological conditions for digital competence formation.

Authors' contribution
All authors equally contributed to the research work.

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