Digital Didactics in Professional Education: Limitations, Risks and Prognosis

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Abstract. The relevance of the digitalisation in professional education is caused by the global transition to a digital economy and society. Building a digital economy and digital education are significant priorities of state policy in the Russian Federation. It is necessary to take into account that the education digitalization has two sides: firstly, the formation of a digital educational environment as a set of digital learning tools; second, the profound modernization of the educational process. The digitalization of educational process is a reciprocal transformation, on the one hand, and the digital technologies and tools used in the educational process, on the other. The aim of the educational process transformation is to make the fullest possible use of the potential didactic capabilities of digital technologies. The aim of digital technology transformation is to maximize its adaptation to effectively meet the pedagogical objectives. The expected educational outcomes of the digitalisation in professional education are related to identifying and maximising the potential of digital technology.

Keywords: transition process, electronic educational resources, digital education, reciprocal transformation, educational transformation, digital technologies.

1 Introduction

Digital technologies make it possible to create an environment with a variety of educational resources, almost unlimited in content. Under these conditions, it is up to the individual (perhaps with some help from teachers, tutors and/or the adaptive learning systems) to solve a number of educationally important tasks, the first of which is to comprehend and formulate his/her own educational needs and on this basis to form an individual educational track. The first task is to think about and formulate one's own educational request and, on that basis, to create an individual learning path. In the conditions of distance learning online courses, the learner is required to be able to independently organise his or her learning activities at all stages of the educational process. Consequently, the digital learning environment is a complex of conditions and opportunities for human learning, development, socialisation and education.

Digitalisation, as a priority project of higher education, aims to improve the quality of professional education through digital technologies [1]. The regulatory process calls for higher education institutions:

- to update the education and training system;
- to form a digital learning environment;
- to introduce digital learning tools;
- to prepare a specialist in accordance with the requirements of the digital economy.

In this research paper, we view digital didactics as a process of constructing a set of digital educational technologies and teaching methods, electronic resources, which allow the budget and rapid implementation of integrative and competence-based approach to learning and the professional competencies formation and professional activities readiness. The digital education development is one of the top priorities worldwide [2-4]. Higher education is being integrated into "going digital" and transferring educational activities online, while analogue, traditional education is becoming the part of the past. Higher education institutions are at the stage of rethinking and upgrading the educational process and didactics, searching for effective digital educational technologies that will prepare graduates for the modern labour market requirements [5]. With digitalisation, the spread of telecommunication and networked technologies and learning tools, the subject matter of digital didactics is expanding considerably. This expansion takes place in the following directions:

- From teaching and learning limited to the classroom to learning in different environments and spaces including the networked and virtual world;
- From the learning process in an educational organisation to learning in an educational network and self-learning in an educational environment;
- From the teaching and learning activities to the processes of designing, shaping and mastering educational tracks;
- From teaching as the leading activity to the variety of pedagogical functions in the digital learning process.

Having analysed the online education resources, we found out that Russian universities are:

- actively modelling and creating a digital educational environment, the learning process digitalization (digital libraries, campuses, teaching laboratories, etc.);
- information and communication resources are enriched and expanded;
- new educational technologies, methods and techniques of work, interaction formats are developed and implemented;
- training and retraining of "digital" teachers, providing throughout the learning process.

2 Methods and results

The empirical basis for the study was set of regulatory documents:

- the programme “Digital Economy of the Russian Federation”;
- Presidential Decree No. 203 of 09.05.2017 “On the Strategy for the Development of Information Society in the Russian Federation for 2017-2030”;
- the federal project “Modern Digital Educational Environment in the Russian Federation”;
- the materials of a number of international and national conferences and forums, analysis of foreign and Russian experience in online education;
- analysis of publications (articles, theses, interviews, research results), online platforms and distance learning systems.

We have studied the topical issues of digital didactics in professional education based on:

- the review of digital educational resources;
- analysis of professional community problems in the era of digitalization;
- the study of digital educational environment;
- the main trends of digital education in higher education.

The work was carried out based on the integrative-competence approach, which considers the multifaceted pedagogical process as a single whole, giving a new qualitative result, as an integrated characteristic, determining the readiness of a future specialist for professional activity and his/her professional competence [7].

The research methods are:

- bibliographical review and analysis;
- retrospective and terminological analysis;
- questionnaire and personal survey;
- monitoring, observation of students' activity products.

The digitalization prerequisites and its evolutionary trajectory are considered in a number of sources:

- The process of informatisation and computerization and large-scale Internet connectivity took place in 1980-1990. Computers became a didactic component of the training process.
- From 2000 to 2006, information resources were increased, and distance education was introduced.
- Between 2016 and 2020, global telecommunications developed and digital educational services emerged.
- In the future, digital campuses in higher education institutions and a new generation are expected to be completed by 2035.

3 Discussion and Results

3.1 Professional education digitalisation: Limitations

1. Social inertia is a limitation related to the unpreparedness of society (public opinion) and its institutions (legislative system, public administration, training system) for the changes that the digitalization process entails. A particular case of this limitation is the unwillingness of pedagogical staff to quickly abandon traditional pedagogical approaches and teaching methods and to "digitally transform" their professional activity. The overall effect of social inertia on the digitalization process is that change does not happen as quickly as its initiators would like it to. At the same time, the social and psychological mechanisms of social inertia are aggravated by a lack of resources for change, including lagging regulatory and methodological updating [8].
2. The importance of the human factor in the educational process is a limitation due to the impossibility of permanently excluding live interpersonal communication from the educational process and its complete automatization or transfer to a network format. Human beings are social beings, and they need a process of live communication to develop fully. Contrary to a recent popular belief, human beings, and not digital media, are the most powerful source of motivation in learning. The inefficacy of "machine learning" was exposed as early as the turn of the century 60s and 70s, by experiments in various countries that introduced the programmed-learning model [9, 10]. Under a programmed learning environment, the individual loses subjectivity and essentially becomes a machine-like element of an automated educational system, strictly acting according to a pre-determined algorithm. The use of modern digital technology, in itself, is only able to create an ad hoc, short-term motivation to learn. On the other hand, after exposure to online courses, a number of students have or become reluctant to attend classroom (traditional) classes [11].

The "human factor limitation" is least important for short programs of professional training and further education, and most important for long programs of secondary vocational education, which inevitably include educational (value-oriented) and personality-developmental components [13]. In addition, it should be taken into account that many universal competences can be fully formed only on the basis of personally significant, meaningful activity experience, obtained by the student in the real environment of human communication, full of emotions, struggle of interests, conflicts, requiring empathy, included reflection, immediate and accurate human reaction, etc. Similarly, developing professional competences in most cases requires immersing the learner in a real professional context, with its inherent interpersonal relationships, role positions, communications and interactions.

3. Practice-oriented - the requirement to organise the practical part of the educational process on a full-time basis in some professions and specific professional education, due to the necessity of personal contact between a teacher and a student to form complex professional skills and competences. In Russia, this restriction is enshrined in legislation. Being on the one hand a didactic principle and on the other hand a limitation, practice-orientation is the central factor which determines the

specificity of the digitalisation process in professional education and training and the specific parameters of this process (orientation, dynamics, breadth).

4. The quality of technical resources which support the digital education process may be a significant limitation which limits its pedagogical effectiveness. For example, according to one survey conducted with students in the system of distance education, the biggest obstacle to their learning is internet interference (53.2%) and the quality of sound (20.6%) [14].
5. A set of health and hygiene restrictions requires that the educational process take into account the negative effects of digital technologies on the health, functional and emotional-psychological state. Negative results of work with computers include: decreased vision, various signs of fast fatigue, the occurrence of neurological symptoms, etc [15]. Hygiene and sanitary restrictions are of particular importance when working with young children, including adolescents studying in vocational programmes.

3.2 Professional education digitalisation: Risks

There is a danger of the social institutions dehumanization, which in professional education is manifested as a loss of educational and personality-development goals and a focus on the narrow functional training of the future employee [16].

Computerization inevitably affects with great risks associated with:

- the direct antagonism between the human and the computer in “human-machine systems”, which forces the human being either to be excluded from such systems or to become "computer-like";
- with the development of technocratic thinking, characterised by the domination of means over ends, and of technology over man;
- the irrationalism spread, the loss of capacity to think critically and to perceive reality adequately against a background of information noise, flaming and massive misinformation dumping.

1. The risk of distorting thinking, attitudes and value systems.
2. Risk of excessive “digital optimism” - exaggerated possibilities assessment of digital learning environment, digital resources and learning tools, combined with underestimation of human factor significance in educational process. The flip side of “technocratic optimism” is always “humanitarian pessimism”, where humans are seen as the least effective component of human-machine systems. As a result, at the design stage of such systems there is a tendency to displace humans (in the case of educational systems - the teacher, as well as opportunities for live communication between learners).

The transition to digital education is expected to lead to a significant reduction in the role of the teacher in the educational process with a dramatic increase in the importance of self-learning through digital technologies. At the same time, the digital educational environment, the system of online courses and other educational resources are considered as self-sufficient means to ensure high efficiency of the educational process. However, in the countries that are ahead of Russia in their development, the hopes for the transition to mass distance education have not been fulfilled.

According to a study by the University of Pennsylvania (2013), of all registered users on Coursera, from 27 to 68% have watched at least one lecture, and only from 2 to 14% have completed more than half of the course or the entire course [14]. Characteristic of this is the recognition by an international group of futurists that "human-to-human learning is likely to continue to be a key development process, the most effective form of learning for both guided and 'self-directed' learning".

3. The risk of replacing education with digitisation. Pedagogically ineffective 'digitised' didactic practice is characterised by a combination of the following:

- Firstly, the use in digitised form of traditional didactic elements of the educational process (class and lesson system, content, forms and methods of teaching, the former system of evaluation and control of knowledge) without any fundamental transformation;
- Second, the use of universal information and communication technologies that are not focused on solving specific pedagogical tasks;
- Thirdly, there is a lack of scientific understanding of the first two points.

Thus, the “digitized” didactic practice is based on the empirical mutual selection of available didactic support (content, forms and methods) and the most accessible information and communication technologies. A digitised textbook, for example, is a traditional, digitised text, with hyperlinks and links to external resources, but perhaps also “live images” - animations and video clips. Its use may be able to create a slightly higher learning motivation in today's children than in a conventional educational process, but this motivation is external and short-lived. Using an electronic textbook instead of a printed book considerably increases the strain on the eyesight. But the main problem with “digitised” didactic practice in this case is that the learning strategy of the textbook does not change, or changes for the worse, losing its humanistic component. The latter happens because the teacher, trusting in the power of the digitized textbook, increasingly withdraws from the educational process, making room for dialogue “learner-computer” [15].

Even the individualised learning opportunities that the digitisation of traditional educational media brings with it often have a negative impact on development: the learner is locked into a personal computerised learning environment, to the detriment of group forms of work. In contrast to “digitized” traditional didactics, digital didactics involve rethinking and essential transformation of the existing educational process and its elements (see Table 1).

Approach	Educational process objectives	Learning content	Dominant sub-process of learning	Learning forms	Learning tools
Traditional didac-	Traditional: learning	Products of social expe-	Teaching	A dominance of frontal	Textbook, printed visual

tics	certain social experiences represented in a didactically adapted form of "knowledge", "skills", "attitudes" (worldview)	rience represented in the iconic form of learning information ("knowledge")		forms of classroom work and individual forms of independent work	aids, occasional use of real objects
"Digitised" didactics (transitional phase)		The different ways of doing things to be learned		Frontal, with attempts at individualisation and a pronounced lack of group forms	Digital, occasional use
Digital didactics	Preparing to live effectively in a digital economy	Different ways of doing things to be learned	Learning	Dominance of group and individual forms of learning, dynamic forms	Digital (information and communication technology, pedagogical technology)

Table 1. Contrasting the features of "digitised" didactic practice and digital didactics

There is a risk of "digitization" learning in professional education, when using a set of simulators, simulators and other meta-digital technologies (software and hardware complexes), the process of professional competence formation is transferred from a real professional context to a virtual one.

Achieving the professional education goals - mastering professional competences, supporting the professional processes and personal self-determination, professional identification, socio-professional adaptation of a young person - requires a flexible combination of digital, material and pedagogical technologies [17].

4. The pressure of digital developers is due to a lack of activity in the education sector in the role of digital educational products. The digital products' developers, being unfamiliar with the educational process and having little understanding of pedagogical goals and didactic principles, view education in the superficial context of a "service". As a result, many promoted digital products that are positioned as educational do not aim to achieve meaningful pedagogical goals, but instead provide secondary objectives, sometimes not directly related to learning objectives.

Overcoming this risk requires a systematic analysis of the digital learning products' development for professional education:

- educational needs and goals;
- the digital generation features, the learners' and teachers' capabilities;
- actual and potential didactic properties of the different digital technologies;

— didactic principles and characteristics of the educational process in professional education and training.

The solution to this problem requires the introduction of a new professional position, that of methodologist-architect of digital learning tools, who acts as a qualified intermediary between the pedagogical community, familiar with didactics, and the developers of digital products. The main task of the Digital Learning Resource Architect is to identify the current gaps in the practice of teaching and to develop terms of reference, in a language that the developers can understand, for the development of digital learning tools that are actually needed to solve the pedagogical problems at hand. They should have an in-depth understanding of didactic theory and educational practice, a good understanding of digital technologies, including the most modern, systematic analysis and constructive communication skills [18].

5. The ethical digitalization risks in the educational process are primarily due to the accumulation of large amounts of personal information about learners (including that related to their health, individual psychological characteristics, value preferences, social contacts, success rate in various activities). In essence, all relevant aspects of a learner's life are tracked in the digital learning process. There are inevitably risks related to the transparency of this information for the different actors involved in the educational process (teachers, parents, administration, digital footprint analysts, other support staff) as well as its possible leakage. Thus, when developing digital learning platforms and systems, special attention should be paid to information security, both in technical and pedagogical terms (identifying who has access to what information, establishing appropriate contractual arrangements, etc.).

6. Management risks related to the process of digital education:

— Digitalization for the education purpose, training and development, formation of socially and professionally important competences demanded by the digital society, digitalization for utilitarian purposes of making the educational process cheaper, simpler and more manageable;
— haphazardness and haste in innovation (resulting in the risk of psychological and functional unpreparedness of teachers to work in the digital education process), voluntarism, lack of scientific validity in the proposed approaches and solutions;
— focus exclusively on formal indicators of “administrative quality” of education (availability of high-speed Internet, provision of digital technology and the ability of teachers to use it, the number of developed online courses, the place of Russia and its educational organizations in international ratings, etc.), ignoring or underestimating the social and semantic indicators of social and didactic quality of the digital educational process [16].

To minimise management risks, it is necessary to

— organisation of scientific research into the process of digitalisation and the digital educational process of professional education and training, including by organising

a network of experimental sites on the basis of educational organisations, educational networks, professional and educational clusters;
- organisation of comprehensive substantive monitoring of the process of digitalisation of vocational education and training;
- organisation of systematic professional development pedagogical and managerial staff of professional education for developing new competencies, providing readiness to work in the conditions of digital education process;
- development of a set of methodological recommendations for the heads of professional educational organisations, teachers, industrial training supervisors, teachers of additional education, curators of groups (class teachers), educational psychologists to work in the conditions of the digital educational process.

3.3 Digital didactics development: Prognosis

Building digital didactics for professional education involves solving a set of new tasks which require full-fledged scientific and experimental research. The following are some of the research tracks.

1. Development of dynamic and open model of expected educational outcomes of professional education ("floating goals" of educational process) as well as model of personalized educational process flexibly adjusting for continuously changing goals.
2. Construction of the compensatory model of the educational process, providing levelling the negative features of the digital generation.
3. Advance in learning autonomy as a readiness to independently, actively and effectively use the competences of the digital learning environment.
4. Determining the pedagogical balance between the didactic principles of personalization (freedom of choice) and flexibility (adaptability), i.e. between electivity and selectivity, in constructing individual educational tracks and in other aspects of individualization of the digital educational process.
5. To reflect on the didactic potential of new and constantly improving digital technologies, as well as ways for using them to achieve pedagogical goals and solve current problems in the educational process. Development of new digital-based pedagogical technologies, testing and improvement.
6. Identifying deficiencies in the educational process of professional education, creating new and upgrading existing digital learning tools and electronic educational resources. This includes the development:

- Adaptive learning models that provide automated personalized adjustment of the digital learning process to individual characteristics and take psycho-physiological conditions into account.
- Approaches to the learning experience design in a digital environment.
- Virtual models of substitution communication, ensuring the achievement of the educational objectives.
- Digital tools which enable the automation of routine elements and, at the same time, prevent "monotony effects" in the consolidation process.

- Approaches, methods and tools for managing learning motivation at different stages of the digital learning process.
- Digital tools for inclusive assessment for different types of learning activities.

7. Determining the ratio and alternation of virtual and real professional components in practice-oriented professional education. Conditions' identification for pedagogical effectiveness of existing meta-digital learning complexes, the pedagogical demand for their modernization, ensuring the professional skills creation, abilities and competencies for the digital economy.
8. Pedagogically appropriate infographics use in the educational process, as well as methods and tools for the combined figurative-logical thinking.
9. Teacher's role in the digital education process; formation, description and continuous updating of a dynamic set of his/her competences; identification and description of his/her new job functions, including in the form of new pedagogical professions for digital education.

4 Conclusions

The transition to the digital learning process significantly transforms the professional activities of pedagogical staff in professional education. Three groups of roles are actualized, which provide different levels of interaction in the digital education process:

1. Educator (specialist) ↔ learner (group of learners): organizer and motivator of learning, trainer, game technician, project activity specialist, developer of environments for group project work, developer of educational trajectories, manager of individual educational tracks (interdisciplinary tutor (the student's personal trajectory is supervised for a long period of time and is involved in solving individual educational problems, coordinating the activities of teachers working within the individual curriculum; on the basis of longitudinal observation of the student and analysis of his/her learning success he/she gives recommendations for further development of the educational trajectory.), etc;
2. Educator (specialist) ↔ digital technology and tools learner (group of learners): integrator-mediator between virtual world and real world, network educator-curator (online tutor (Compiles online courses for distance learning, adapting the requirements of specific disciplines to the online environment, and administers the operation of the online education platform.)), internet navigator, digital footprint analyst-corrector, web psychologist, etc;
3. Specialist ↔ digital technologies and tools: methodologist-architect of digital learning tools, developer of educational digital environments, electronic educational resources expert, etc.

At the same time, in the digital education process, many of the traditional roles of the educator – "knowledge-bearer", informer, explainer, checker, reprimanded and "punisher" for non-compliance, etc. - are losing their importance. In general, multidisciplinary,

"convergent" professionals are increasingly in demand in digital education as in many other sectors of the digital economy. Practitioners with experience in various social, industrial, business projects will be in more demand in the digital educational process of professional education and training than traditional "mono-professional" educators.

Terminological analysis has identified a bank of new terms for the problem: "digital pedagogy", "digital learning environment", "digital educational resources", "digital learning", "digital culture", "digital marketing in education", "blended education", "flipped learning", "digital educator", "online professor", "digital student", "interactive education", "digitalisation", "smart university", "artificial intelligence", "digital cluster", "digital communication", "E-didactics".

Having analysed the main tools of digital didactics in professional education are:

1. *Personalized education process* - as the transformation of the educational process into a set of individual educational trajectories that take into account, on the one hand, the personal educational needs and demands of the students and, on the other hand, their individual psychological, pedagogical and medical (for students with disabilities) characteristics. The personalisation of learning is achieved by:

- Individual educational trajectories;
- The use of distributed forms of the educational process;
- The use of adaptive technologies;
- Creating an educational environment for independent work, self-education and self-development.

2. *Digital pedagogical technologies* - has the potential to provide an almost infinite number of pathways for individualisation of learning (including: content, learning pace, complexity, delivery mode, activity form, group size, repetition rate, external assistance degree, openness and transparency for other participants, etc.). It is important that all these areas can be implemented simultaneously, which allows adjusting the educational process to each specific student (adaptability principle), ensuring a high level of learning motivation and full assimilation of the given educational outcomes. Individualization of vocational education and training on the basis of digital technologies allows for an organic transition to multiprofessionalism - a post-industrial model of professionalism, when a profession ceases to be a standardized set of labour functions and actions, in-demand knowledge, skills and abilities - and becomes a dynamic personalized set of competencies.
3. *Meta-digital educational (hardware and software) complexes*, both training (simulators, augmented reality tools, sensors capturing the quality of a single work action, etc.) and used directly in the production process of enterprises, are of particular importance in the digital educational process of vocational education and training. The use of such complexes is a prerequisite for shaping a learner's professional skills and competencies needed to work in the chosen occupation (speciality) or within the framework of the work function being mastered. Under the conditions of digitalization, the partnership between a professional educational organization and employers acquires the form of a unified production and training digital environment. For example, students can be trained in a situation centre where they can remotely observe real production processes, participate in discussion and analysis of

emerging production situations (including problematic ones), and develop solutions.

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