

# The Organization of Scientific Research Work of Students in the Conditions of the Digital Environment in the Modern Universities

Yulia Bogatyreva  
Tula State Pedagogical University  
L.N. Tolstoy,  
Tula, Russia, 300026  
bogatirevadj@yandex.ru

Alexander Privalov  
Tula State Pedagogical University  
L.N. Tolstoy,  
Tula, Russia, 300026  
privalov.61@mail.ru

Vladimir Romanov  
Tula State Pedagogical University  
L.N. Tolstoy,  
Tula, Russia, 300026  
romanov-tula@mail.ru

Ekaterina Konopko  
North Caucasus Federal University,  
Stavropol, Russia, 355000  
katar\_for@mail.ru

## Abstract

Relevance. One of the tendencies of modern higher education is the digitization of all spheres of vital activity of modern Russian society. The process of inevitable “digitalization” changes the forms, means and types of education in the system of higher education. One of the innovative areas can be the organization of research work of students in the digital educational environment of students of IT training areas.

The purpose of the article is a pedagogical understanding and development of recommendations on the use of a system-activity approach to the organization of research work of students in the digital educational environment of an educational organization. The digital environment of educational organizations, created on the basis of means of informatization and digitalization, acts not only as a condition, but also as a means of organizing training and education, as well as the implementation of research work of students.

Methodology and methods. The system-activity approach has become the leading approach to the study of the problem under discussion. The work used the methods of socio-historical and theoretical-methodological analysis, modeling, synthesis of effective teaching experience of educational organizations.

Results and scientific novelty. The article discusses the content and technology of the organization of research work as an essential component of vocational training of students in the digital environment of

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an educational organization. The very concept of “digital environment of educational organization” was clarified, components and directions for its expansion were identified and presented. Practical recommendations are formulated for organizing the research work of students of IT areas of training in educational professional organizations.

Practical significance. Research materials may be of interest and demand by managers of education, the administration of educational professional organizations.

Keywords: digital environment, informatization of education, research work, training, students of IT training areas.

## 1 Introduction

One of the recent trends in the Russian Federation is the policy adopted by the state to digitize socially significant spheres of social life. The process of ubiquitous digitalization inevitably changes the structure of employment of the population and the education system as a supplier of personnel who will work in completely different conditions compared to previous ones. The digital transformation of modern society puts on the agenda questions about the innovative forms and forms of training for students that are adequate to the current state of society and the tasks of economic development. One of these areas could be the organization of research work of students in the digital environment of educational organizations, presented in this article.

The widespread introduction of digital technology inevitably causes many and diverse changes in the economic, political and social spheres of society. The digital trends observed today (distance education, Internet things, artificial intelligence, etc.) cover almost all spheres of life: from medicine and education to hobbies and travel, and are characterized by the “clean-up” of the economy and are carried out in the created digital environments. In order to implement the Strategy for the development of the information society in the Russian Federation for 2017–2030, the Decree of the Government of the Russian Federation (order No. 1632-p dated July 28, 2017) approved the program “Digital Economy of the Russian Federation” [Pro17].

This program identifies goals such as the creation of an ecosystem of the digital economy of the Russian Federation, in which data in digital form is a key factor of production in all areas of socio-economic activity.

One of the basic, critical areas of the Digital Economy of the Russian Federation program is the Human Resources and Education project, whose roadmap contains 5 main objectives:

1. Creating a system of citizen motivation for the development of the necessary competencies and participation in the development of the digital economy of Russia.
2. The education system should meet new challenges, promote the comprehensive development of students, prepare competent personnel for the digital economy.
3. Creating key conditions for training the digital economy.
4. Employers should promote staff development to meet the demands of the digital economy.
5. Creating conditions for the implementation of the direction "Personnel and Education" of the program "Digital Economy of the Russian Federation" [Pas17].

After the implementation of the program's activities for 2018–2021, the plan's developers expect concrete results: training and testing programs will be developed to form the core competencies of the digital economy, a system of standards for the competencies of the digital economy will be expected for all ages. According to [Pas17], by 2024 at least 800 thousand graduates of the vocational education system should have competencies in the field of information technology at the global average, and at least 120 thousand graduates of the higher education system will be trained in IT areas.

Unfortunately, the degree of investigation of the problem of training human resources in the conditions of digitalization does not correspond to its importance. There is a shortage of IT-specialists of the required profile and the required qualifications, which in the future may lead to serious social difficulties [Rod17], [Bab18].

In view of all the above, in Tula State Pedagogical University L.N. Tolstoy conducted systematic work on training for the digital economy. After analyzing the labor market in the Tula region, the graduating department of informatics and information technology has chosen the following areas of undergraduate training as:

09.03.03 Applied Informatics (Applied Informatics profile in healthcare).

02.03.02 Fundamental informatics and information technologies (Open Information Systems profile).

02.03.03 Mathematical support and administration of information systems (Information systems and databases profile).

Professional training for the bachelors of the above IT areas has the following psychological, pedagogical and organizational features, consisting in extremely rapidly changing paradigms and technologies of the subject area, on the one hand, and, on the other hand, the requirements of the market to prepare future professionals to solve specific problems in a digital economy at the stage of their training.

Starting from 2019 year, the department of informatics and information technologies plans to prepare masters in three areas within the framework of the above areas of training:

1. Medical informatics.
2. Information systems and databases.
3. Applied informatics and modeling of technological processes.

The areas of professional activity of graduates who have mastered the undergraduate program are mathematical and algorithmic models, database technology, computer graphics, information theory, software architecture, information technology, information systems, development, implementation and operation of software for various purposes. Graduates of the department also receive fundamental mathematical knowledge in the field of discrete mathematics, probability theory and mathematical statistics. In addition, they learn classical and modern programming techniques and techniques, master web programming languages.

## 2 Task

In the context of the digitization of socially significant areas of society, we will highlight such a phenomenon as “digitalization of education”, which involves ensuring the wide availability of information digital resources and the use of digital technologies in the educational process [Sei16], [Shk16], [Nos18].

Currently, the transition from the introduction of individual information and communication technologies to the integrated construction of the digital environment across the entire educational organization is underway. The formation of a digital educational environment of an educational organization (DEE EO) is an urgent need, since a university, school, college has a special mission, which is to prepare a comprehensively developed graduate who has the necessary set of competencies and competencies ready to continue education in a highly developed digital society [Kon16].

Considering the original concept of “digital environment of educational organization”, we note that its genesis and essence are contained in the broader concept of “educational environment”. Today, in every educational organization (school, lyceum, college, university) a complex of computer equipment, various software, data transfer, display and information storage facilities, electronic educational resources, which are widely used in the educational process, are successfully operating. In addition, students themselves actively use mobile phones, smartphones, personal digital assistants, as useful add-ons that help store, view information, and carry out communication activities. Thus, there is every reason to assume that there is a possibility of transformation and expansion of the information and educational environment and the transition to the digital environment in universities [Sk19].

According to some teachers (Yu.I. Bogatyreva, E.N. Boyarov, A.N. Privalov, V.N. Kormakova, A.B. Malofeeva, E.Yu. Tikhonova E.Yu., etc.) [Pri17], in the educational environment there is an interaction of different directions and intensity, the development and reproduction of social and socio-cultural experience of the individual is carried out. In this connection, in our opinion, a holistic understanding of the category “educational environment” is necessary. Like any environment, the educational environment contains those components of the general environment of society (factors, conditions, resources) that are in substantial interaction with the education system. Many of these components are created by education itself, others are provided by the external environment [Bog13].

Analysis of research in this area has shown that the information and educational environment is interpreted very ambiguously [Far16]. This is also “a systematically organized set of information, technical and educational support, inextricably linked with a person as a subject of the educational space” [Efa16]; and “a single information and educational space built with the help of information integration on traditional and electronic media, computer-telecommunication technologies of interaction, including virtual libraries, distributed databases, educational and methodical complexes and advanced didactics apparatus, etc. [Hen14].

Digitalization of the educational environment can occur in various forms:

- 1) translation of available training materials, including lectures, presentations, textbooks, tasks for independent work and knowledge control tools, into an electronic environment;
- 2) the formation of an interactive electronic environment of interaction between the teacher and students, including the creation of electronic classrooms for teachers, webinars, discussion forums, online lectures, etc. ;

3) the use of new types of educational tools: electronic textbooks, electronic task books, video lectures, quests, computer games;

4) the creation of fundamentally new forms of learning by using the capabilities of the electronic environment - expanding the range of imaginative information transfer, modeling various situations in the course of role-playing games, simulating competitive games, etc .;

5) the inclusion in the learning process of the capabilities of artificial intelligence [Ust18].

Based on this, DEE EO is a complex of information educational resources, including digital educational resources, a set of technological means of information and communication technologies: computers, other ICT equipment, communication channels providing training in a modern information and educational environment.

The value of the digital environment in educational organizations has recently increased significantly, it qualitatively affects the educational process, all subjects of education and their relationships in the educational system. The term "digital educational environment" denotes a new essence of integration of educational, information environments and a complex of digital means.

From this point of view, one can imagine the following set of functions of the University DEE EO:

1. scientific and methodological support of educational activities at the university (development, storage and use of teaching materials, lecture texts, description of laboratory work, etc.);

2. interactive support of the educational process with the inclusion of visualization;

3. ensuring the monitoring of students' knowledge, built on an intelligent testing system;

4. organization of the work of virtual laboratories and hypermedia educational space;

5. informational support for the implementation of the students of coursework and final qualifying works;

6. expanding the information base (full-text electronic library, access to electronic library systems, dictionaries, glossaries);

7. organization of distance learning;

8. organization of virtual communication of participants in the educational space, the accumulation and dissemination of teaching experience, professional development of teachers;

9. expansion of research and project activities of students.

Next, we will look at how the digital environment of an educational organization, created on the basis of informatization and digitalization tools, acts not only as a condition, but also as a means of organizing training and education, as well as implementing research work of students.

### 3 Development Of Methodology

#### 3.1 Research Work Of Students As One Of The Forms Of Professional Training At The University

Student participation in research and development is an important component of higher vocational education. Note that in the context of the discussion of issues relating to the preparation of bachelors and masters of IT-directions, this component acquires a very special significance. The purpose of the research work is to develop the ability of undergraduate and graduate students to the ability of independent theoretical and practical judgments and conclusions; formation of skills for an objective assessment of scientific information, free scientific research and aspirations for the application of scientific knowledge in professional activities in areas regulated by the FGOS of higher education in the relevant area of training; developing bachelor competencies and skills of independent research work, as well as research as part of the research team.

The students' research skills consist in the ability to consciously perform actions on searching, selecting, processing, analyzing, creating, designing and preparing the results of cognitive activity [Kol09]. Student research in all universities is mandatory. Its main stages are regulated by the curriculum and work programs of disciplines.

Traditionally, the concept of "student research work" (SRW) is identified with the forms of attracting students to the scientific work of the department, as well as the departmental and university laboratories, the implementation of educational research projects, coursework, final qualifying (diploma) works, master's theses, participation in conferences, seminars, competitions, exhibitions.

As a result of the development of educational programs, graduates should be prepared to carry out the following types of research work:

– fulfillment of research tasks;

– participation in the implementation of the planned research work of the department, including on contractual research topics;

– preparation and protection of the results of research conducted in the form of a report, article, report, term paper, final qualifying work; master's thesis;

- the ability to practically carry out research, apply empirical methods of collecting and analyzing information related to IT topics;
- development of scientific reports, reports and abstracts on topical issues of the development of information and communication technology tools, digitalization of society, economics, medicine and education;
- preparation of scientific articles and theses on various aspects of the development of the digital economy for publication in collections of conference materials;
- ability to work with specific software products and information resources;
- Participation in competitions for the best scientific work in the framework of the university, as well as at All-Russian and international competitions.

The functions of the research work of students in the learning process at the university are presented in the system:

- educational: mastering theoretical (scientific facts) and practical research methods, methods of conducting experimental research, methods of applying scientific knowledge;
- organizational-orientational: the formation of the ability to navigate sources, literature; development of skills to organize and plan their activities; selection of information processing methods;
- analytical and corrective: student reflection, introspection, correction of educational and cognitive activity;
- motivational: the development of interest in science in the process of research, cognitive needs; stimulation of self-education, self-development;
- developing: the development of critical, creative thinking, the ability to act in standard and non-standard situations, the ability to justify, defend their point of view; development of abilities (cognitive, communication, special abilities, etc.);
- upbringing: the formation of moral and legal identity; fostering the ability to adapt in a changing social environment; the formation of adequate self-esteem, responsibility, dedication, willful self-regulation, courage in overcoming difficulties and other abilities and character traits. The educative function also includes the education of vocational vocation and professional ethics [Sha04].

In the system of higher professional education Kutumova A.A. and Kushnir T.I. there are several areas for the application and implementation of the types and forms of research activities of students:

- enrichment of traditional academic forms of organization of the educational process (lectures, seminars, practical and laboratory classes) with the fulfillment of research-type tasks;
- development of extracurricular forms of involving students in scientific activities (for example, writing scientific reports, articles, preparing reports; holding olympiads and scientific conferences; developing projects for obtaining grants; optional forms of education; forms of scientific cooperation; university — production, etc.);
- the introduction of less common higher education-specific collective forms of scientific and practical activities of students (research circles, groups of young researchers, etc.) [Kut14].

### **3.2 Organization Of SRW At The Department Of Informatics And Information Technology**

The research work of students at the Department of Informatics and Information Technologies is a continuation and deepening of the educational process, one of the important and effective means of improving the quality of training bachelors, masters and graduate students. The objectives of the scientific work of students are the transition from the assimilation of ready-made knowledge to mastering the methods of obtaining new knowledge, the acquisition of skills for independent analysis of the information obtained using scientific methods.

In this regard, the forms and methods of attracting students to research and development work at the Department of Informatics and Information Technologies can be divided into research work included in the educational process and, consequently, conducted during study time in accordance with the curriculum and work programs (various types of studies with elements of research, teaching research work of students), as well as research work carried out by students outside extracurricular time.

An important form of research work of students performed during school hours is the introduction of elements of scientific research into laboratory work. When performing such work, the student independently draws up a plan for completing the work, selects the necessary literature, performs mathematical processing and analysis of the results, draws up a report. All students perform laboratory work in the form of a virtual report in a digital educational environment. As a mechanism for the implementation of such practices in the TSPU L.N. Tolstoy uses the LMS Moodle environment. Tools, such as MOODLE systems, provide objective information about the quality and dynamics of each student's SRW. The use of electronic monitoring in the digital environment provides an opportunity to assess the activity of a particular student in an electronic course, which, undoubtedly,

can be taken into account when accepting individual tasks or independent work. The statistical report on the course provides an opportunity to collect information on viewing a particular element of the course, the time of its last visit, the activity of students in the course element for a certain period of time (see Fig. 1).

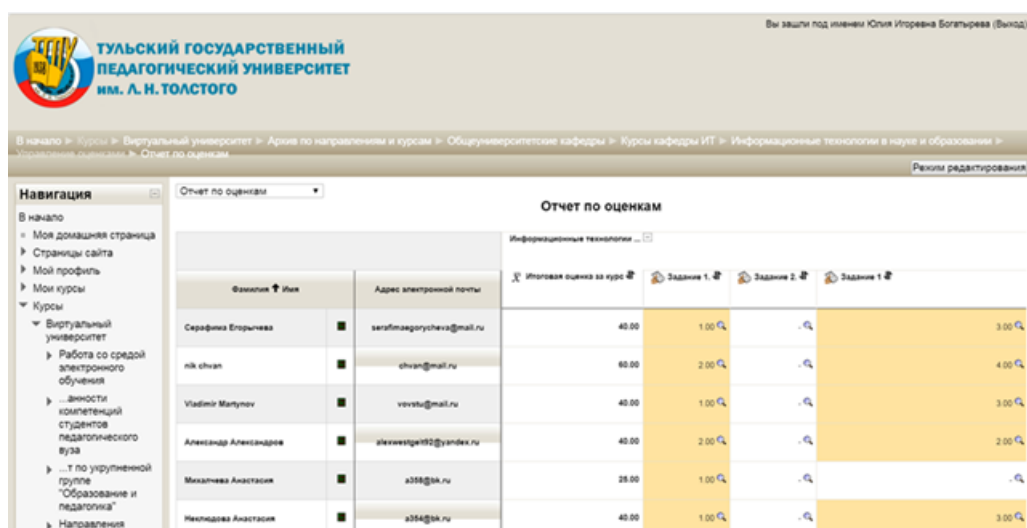


Figure 1: LMS Moodle for storing and evaluating student lab reports

During extracurricular activities, various problem groups and circles are actively organized and conducted for undergraduate students at the Department of Informatics and Information Technologies: Methods of database application development.

1. Solving Olympiad programming problems.
2. Programming in C ++.
3. The use of web technologies in the development of sites.
4. Educational robotics.
5. Office programming on VBA.

In the digital environment of an educational organization, when organizing problem groups and circles, it is possible to expand the forms and tools of knowledge transfer: using network design work in several groups along with traditional activities, organizing group disputes, role-playing and competitive games, including virtual games, using network interaction participants, etc.

At senior courses, students are offered the following forms of SRW: preparation and defense of term papers, final qualification papers; participation in competitions, contests of various levels; research projects (including those paid from grants of various levels in conjunction with teachers of the department); participation in scientific seminars, round tables.

The preparation and implementation of SRW is carried out in close cooperation with enterprises of the IT industry in the region: the state autonomous institution of the Tula region, the Information Technologies Center, the state health care institution Tula Regional Medical Information and Analytical Center, SoftExpert, and Ingate and CodeMaster.

Thus, representatives of specialized organizations formulated, and students implemented and defended such topics as final qualifying papers on the digital economy, such as "Developing a web service for implementing information security policies (for example, an industrial enterprise)"; "Development of software for an automated workplace of a general practitioner"; "Development of a web service for monitoring the functioning of the websites of educational organizations of the Tula region"; "Development of an information system for the sale of external banking products"; "Development of a mathematical model and prototype of a traffic management system based on open data"; "Development of a subsystem of the automated workplace of the logistician".

### 3.3 Innovative Forms Of Stimulating RSW In The Digital Environment

One of the innovative approaches to stimulate research and development bachelor of IT-directions in TSPU L.N. Tolstoy was the creation of the engineering center "Digital means of production" (IC TSPU). It was created in 2017 in order to fulfill the order of the Government of the Russian Federation dated May 23, 2013 No. ODM-P8-3464 and as part of the implementation of the Action Plan ("road map") in the field of engineering and industrial

design, approved by the decree of the Government of the Russian Federation July 23, 2013 1300-p (paragraph 12) in September 2013 [Ord13].

An important aspect of the IC TSPU activity is the actual involvement of the scientific and pedagogical workers working in it in the process of continuous scientific research in solving urgent problems. An additional effect of the participation of students in the work of the IC TSPU is the intensification of their research activities.

In this practice, bachelors and undergraduates of IT-directions are involved in the work at the IC TSPU: out of school time, they actually perform research in the framework of the development of high-tech engineering projects in the profile and areas of training. The inclusion in the research work of students of types and forms of activity on the basis of the IC TSPU today is an innovation in teacher education in terms of training for the digital economy.

Research projects, including those paid for from grants of various levels in conjunction with faculty members, are another form of encouraging SRW students in the digital environment. The department contributes to the creation by students of their own innovative projects, realizing that their success in their future professional activities directly depends on the professional training in the TSPU L.N. Tolstoy. Students annually participate and win in the UMNİK program (Participant in a youth science and innovation competition) organized by the Foundation for Assistance to the Development of Small Enterprises in the Scientific and Technical Sphere (Innovation Assistance Fund) [Inn19]. Since 2014, the winners of the program in the direction of H1 Information technology are:

1. Klepikov A.K. "Monitor-distributor of data in hybrid computer networks" (2014).
2. Smooth I.Yu. "Development of a transport router based on geo-information technologies with dynamic adjustment" (2016).
3. Usikov A.N. Developing a system of "smart" price control (2017).
4. Polyakov PI Development of cognitive simulator software for learning the optimal sequence of movements based on Petri-Markov networks (2019).

## 4 Results

In 2018, students published independently 18 articles on the subject of IT areas, 28 publications in collaboration with the staff of the Department of Informatics and Information Technologies, made presentations on the subject of digitalization of education, economics, medicine at various scientific and educational events:

1. XXI International Student Scientific and Practical Conference "Problems of Youth through the Eyes of Students" (20.04.2018. Tula TSPU named after LN Tolstoy).
2. XIV Regional Scientific and Practical Conference of graduate students, applicants, young scientists and undergraduates "Research potential of young scientists" (February 27, 2018, Tula TSPU L.N. Tolstoy).
3. Regional student's scientific and practical conference with international participation "Youth is the science - the third millennium" (04/22/2018, the city of Tula, TSPU Leo Tolstoy).
4. International Scientific and Practical Conference "Scientific Industry of the European Continent" (Prague, November 22-30, 2018).
5. University scientific and technical conferences of young scientists "Scientific potential of TSPUL.N. Tolstoy in the service of the region" (November 23-24.2018, Tula).
6. Science and entertainment duel Science Slam (04/28/2018, Tula).

In October 2018, a team of students of the Fundamental Informatics and Information Technologies training direction headed by the leaders of the Gladkikh I.Yu. held interactive events on educational robotics at the VIII All-Russian Science Festival Nauka 0+ (Moscow, Expocentre Exhibition Center, October 6-8, 2018).

In 2018, innovative projects were prepared for the IV All-Russian competition of research works of students and graduate students in the framework of the All-Russian Youth Scientific Forum "Science of the Future - Young Science", where relevant projects for the digital environment were presented:

1. Savelyeva D.N., a student of the faculty of mathematics, physics and computer science, 3 course; Section: Digital Technologies; Subject: "Electronic Repair Assistant", Scientific Supervisor: A. Privalov, Doctor of Technical Sciences, Professor, Department of Informatics and Information Technologies.
2. Podgurskaya S.S., a student of the faculty of mathematics, physics and informatics, 3 course; Section: New production technologies; topic: "Using VR-technologies for teaching physics in educational organizations"; Scientific adviser: Bogatyreva Y.I., Doctor of Pedagogical Sciences, Head of the Department of Informatics and Information Technologies, TSPU L.N. Tolstoy.

3. Gorelikova T.V., graduate student 3 years of study, section: Social, economic sciences and psychology; topic: "Formation of teachers readiness to ensure information security in an educational organization"; Scientific adviser: Bogatyreva Y.I., Doctor of Pedagogical Sciences, Head of the Department of Informatics and Information Technologies, TSPU L.N. Tolstoy.

## 5 Discussion

Speaking about the problems of organizing and conducting SRW, it should be noted that some of the bachelor students do not have time to form knowledge and research skills during their studies. The confirmation of this fact is a small percentage of students of 1-3 courses, participating in various forms of SRW.

A survey of the students themselves in IT areas showed that for full-fledged research activities at the university is not enough:

1. Material incentive (76% of the respondents).
2. Free time (36% of the respondents).
3. Information on opportunities for participation in scientific work (13% of the total number of respondents).

Motivational stimulation can be expressed in the form of various incentives, thanks inside and outside the university (messages in the press and on television, letters of thanks to parents, sending information to the school that the student graduated from).

Material incentives can be not only a way to enhance SRW, but also a starting point for increasing its effectiveness. This type of incentive for students can be expressed in the form of allowances to major scholarships, nominations for scholarships of various foundations and organizations.

Another important area of stimulating SRW at the Department of Informatics and Information Technologies may be conducting intermediate assessment forms (tests, exams) in some disciplines in the form of protecting an educational research project, writing a joint publication with a teacher, and giving an in-person presentation at a conference with a report. These types of extracurricular research work must necessarily be included in the point-rating system, approved by the disciplines of the department.

## 6 Conclusion

Summing up, we can draw the following conclusions:

- the emergence of a digital society, the development of a digital education environment, the virtualization of forms and methods of education, the introduction of electronic and distance education technologies require changes in the higher education system in order to train personnel for the digital economy;
- it is necessary to develop the digital environment of the educational organization in order to stimulate and enhance the research work of students;
- to prepare highly qualified bachelors and masters of IT areas capable of professional growth in a digital economy, only by expanding and introducing various forms and types of research work of students in order to train competitive specialists in the digital environment of an educational organization with the full cooperation of the university potential employers, companies, engineering centers and competence centers.

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