doi: 10.18323/3034-2996-2025-3-62-1

Regional model for developing functional literacy in a digital educational environment: concept, implementation, and effectiveness assessment

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Received 20.05.2025 *Revised 29.07.2025* *Accepted 11.09.2025*

Abstract: The civilizational transition generates an objective societal need for the development of functional literacy as a key factor for national security and individual success. In response to this need, a dynamic and adaptive model for developing functional literacy is proposed. Its primary advantage is the ability to integrate the relevant regional context and flexibly respond to the challenges of instability and rapid socio-cultural changes. The role of the regional digital educational environment (DEE) in fostering functional literacy among students was examined, using the Samara Region as an example. Monitoring results of students' functional literacy conducted in 2019 revealed insufficient development of global competencies and creative thinking. To address this issue, the DEE of the region was leveraged to enhance educational quality: students were engaged in project-based activities, their analytical skills were developed, and they were offered contextual tasks simulating real-life situations. Resources of the regional system of supplementary education were actively utilized. Over a four-year period, annual monitoring demonstrated that by 2022, the proportion of students achieving high results increased to 60 % compared to 19.8 % in 2019, representing more than a threefold improvement. These findings indicate the positive potential of using the DEE to create a multifunctional regional educational environment that develops both personal and academic competencies. A key prospect of the study is the transition from episodic monitoring to a continuous formative assessment system based on the DEE, enabling near real-time collection and analysis of educational outcomes at all levels – from individual students to municipalities – for prompt adjustment of the educational process.

Keywords: functional literacy; regional digital educational environment; DEE; global competencies; creative thinking; conceptual model; information systems; monitoring of learning outcomes; digital technologies in education.

For citation: Akopyan V.A. Regional model for developing functional literacy in a digital educational environment: concept, implementation, and effectiveness assessment. *Evidence-based education studies*, 2025, no. 3, pp. 11–23. DOI: 10.18323/3034-2996-2025-3-62-1.

INTRODUCTION

Methods for Assessing Functional Literacy

Within the national project "Education", one of the priority goals is defined as Russia's entry into the top ten countries of the world in terms of the quality of general education. The achievement of this goal is possible only with consistent development and purposeful formation of students' functional literacy. Recent global restrictions associated with the beginning of Russia's special military operation in Ukraine have had a significant and multifaceted impact on the field of education, expressed, in particular, in the temporary suspension of Russia's participation in a number of international studies that assess students' educational achievements and provide a comparative analysis of educational system quality across different countries. Until 2022, three international studies of functional literacy were conducted in Russia: TIMSS (Trends in Mathematics and Science Study) – an international monitoring study of the quality of school mathematics and science education in grades 4 and 8[1]; PIRLS (Progress in International Reading Literacy Study) – an international study of reading literacy and text comprehension in grade 4[2]; PISA (Programme for International Student Assessment) – an international comparative study of education quality assessing the knowledge and skills of 15-year-old students[3]. Currently, Russia uses only the annual national assessment modelled on PISA (conducted by FIOKO – the Federal Institute for Education Quality Assessment[4]). In our research, we rely on PISA, since it has played an important role in shaping the country's educational policy.

[1] *International Results – TIMSS 2023. IEA TIMSS AND PIRLS. URL: https://timss2023.org/results/.*

[2] *TIMSS and PIRLS Home. URL: https://pirls.bc.edu/.*

[3] *Programme for International Student Assessment (PISA). OECD. URL: https://www.oecd.org/en/about/programmes/pisa.html.*

[4] *Activities to Assess the Quality of Education. FIOKO: Federal Institute for Education Quality Assessment. URL: https://fioco.ru/ru/osoko.*

Functional Literacy

Functional literacy is an individual's ability that enables the effective application of theoretical knowledge in practice. A.A. Leontiev wrote: "A functionally literate person is someone who is able to use all the knowledge, skills, and abilities acquired throughout life to solve the widest possible range of everyday tasks in various spheres of human activity, communication, and social relations" [1, p. 35]. The concept of functional literacy emerged almost half a century ago and initially referred to a set of reading and writing skills necessary for addressing real-life tasks [2–4]. Later, the content of the concept underwent changes. Today, functional literacy is understood as a person's ability to interact with the external environment and to adapt and function within it as quickly as possible [2; 5; 6]. A high level of functional literacy at the present stage is a prerequisite for successful adaptation to the surrounding world, a guarantee of self-realization, and, consequently, life satisfaction. The concept of functional literacy highlights the distinction between the formal acquisition of knowledge and skills during education and the ability to apply them in everyday situations. Within the educational process in Russia, the general notion of functional literacy includes six domains: reading literacy, mathematical literacy, scientific literacy, financial literacy, creative thinking, and global competences.

Russia's Participation in PISA

Russian school students consistently demonstrate high results in the international TIMSS and PIRLS studies, which focus on assessing subject knowledge in grades 4 and 8. In 2019, fourth graders ranked 6th in mathematics and 3rd in science in TIMSS, while eighth graders ranked 5th and 6th, respectively. In PIRLS, Russian fourth graders perform even more successfully, traditionally occupying leading positions[5]. However, in PISA, which assesses 15-year-old students, Russia holds only average positions (around 30th place)[6], creating a paradoxical picture. This gap is explained by fundamental differences in the content of these studies: TIMSS tests mastery of the school curriculum, while PISA evaluates the ability to apply knowledge in solving practical, non-routine tasks that go beyond standard classroom situations. For example, the decline in Russian students' financial literacy in 2018 compared to 2015, according to the authors [7], may be attributed to several factors. First, there was a recorded decrease in reading literacy, which could have affected task performance. Second, the transition to computer-based testing and the increase in the number of open-ended questions created additional difficulties, since producing extended responses on a keyboard proved less familiar than handwriting. One cannot also exclude the influence of digital communication practices, which foster habits of concise and clichéd expressions (the chat effect and the Twitter effect). In addition, the new 2018 tasks referred to unfamiliar social contexts and required the use of built-in calculators and multi-step cognitive operations, which posed an extra challenge for Russian students [7].

Digital Educational Environment

Modern education faces the necessity of integrating digital technologies, driven by new economic realities and the need to develop digital competences. However, this process is accompanied by a set of challenges, including dependency formation, insufficient socialization, decreased critical evaluation of information, clip thinking, low motivation, high workload for teachers, the risk of transforming learning from a blended format that includes physical activity into work conducted exclusively with electronic devices, as well as digital inequality [8–10].

The existing problem of digital inequality, according to the concept [11], has a three-level structure, where the first level concerns differences in access to technical infrastructure, the second is related to disparities in digital competences, and the third reflects opportunities for the practical use of digital technologies. Later, the experience of the Department of Digital Education at Herzen State Pedagogical University showed that in education the causes of the first and second digital divides are similar to those identified, while the third digital divide manifests itself as methodological, connected with teachers' difficulties in adopting new values and with the expansion of the range of goals of modern education [12]. An empirical study of pedagogical goal-setting, involving 148 educators (school teachers and university instructors), revealed four levels of adaptation to the digital environment. Most respondents demonstrated the first and second levels, corresponding to minimal changes in pedagogical practice, whereas the fourth level, which presupposes significant transformation of goal-setting in line with the opportunities of the digital environment, was almost absent. Digital tools are used mainly for automating existing processes rather than transforming learning. This indicates that the issues of adopting new values and expanding the goals of modern education have not yet been sufficiently realized in pedagogical practice [12]. This confirms the existence of a profound methodological gap: teachers generally neither recognize nor employ the innovative potential of the digital environment to achieve new educational outcomes, which represents a key barrier to the development of modern education.

Despite all the challenges, the digital educational environment offers significant opportunities for the development of modern education, including the creation of individual learning trajectories, the expansion of access to non-formal education, and the provision of flexibility in the learning process. The advantages also include the possibility of studying regardless of location, deeper individual work, and a wide variety of educational resources [13]. The flexibility and diversity of the digital environment create conditions for personalized learning and students' educational self-realization; however, the implementation of

[5] *TIMSS and PIRLS DATABASES. URL: https://timssandpirls.bc.edu/databases-landing.html.*

[6] *PISA Results. FIOKO: Federal Institute for Education Quality Assessment. URL: https://fioco.ru/Contents/Item/Display/2201684#_ftn1.*

the digital educational environment should be accompanied by corresponding changes in curricula that take into account students' needs for socialization and physical activity, as well as the development of critical information perception and independent thinking [13].

The creation of the digital educational environment represents a disruptive innovation, marking the emergence of a fundamentally new educational ecosystem. Within this transformation, networked learning, according to the authors [14], will take on the character of a "great game" of everyone with everyone, where knowledge, as the product of this activity, will be filled with personal meaning and acquire significant social potential. Hybrid learning, from this perspective, may serve as an effective tool for mitigating the consequences of "shock educational policy" and for bridging the gap between theoretical knowledge and practical application [14]. Contemporary approaches to the organization and management of the learning process indicate that the new didactics of educational interactions is still at an early stage of development. At the same time, digitalization is not a universal solution to the problems that have been accumulating over a long period and have become especially evident in the past 15–20 years under the influence of factors such as the COVID-19 pandemic [14].

Thus, the digital transformation of education is a complex, multidimensional process that requires a balanced approach, taking into account both innovative opportunities and potential risks to students' health and cognitive development, as well as the need to overcome the methodological gap within the teaching community.

The aim of the study is to develop a conceptual model for the formation of students' functional literacy within the digital educational system.

METHODS

Rationale for Assessment Periods

For the comparative analysis of the dynamics of students' functional literacy levels, two key time points were selected: 2019 and 2022. The choice of 2019 as the baseline period is explained by the fact that it represents the last "stable" pre-pandemic academic year. During this period, the educational process was conducted exclusively in face-to-face format with the traditional use of digital technologies, which makes its data a representative reference point reflecting the initial state of the education system before the forced mass digitalization.

The year 2022 was chosen as the final period, since by that time the region had not only completed adaptation to the new conditions but had also purposefully implemented and tested the proposed regional model for the formation of functional literacy using the digital educational environment. This made it possible to assess not the short-term effects of the emergency transition to distance learning, but the stable results of targeted systemic work in the new educational reality.

Since 2020, in the Samara Region:

– all general education institutions have been implementing a regional extracurricular program (170/340 hours per year) aimed at developing students' functional literacy, focused on achieving planned outcomes in accordance with the structural components of different types of functional literacy as defined by PISA;

– in order to evaluate the compliance of the interaction between regional centers (RCs) and district schools in the development of functional literacy skills with the requirements of the regional program for functional literacy formation, the Institute for the Development of Education conducts a methodological audit of the activities of resource centers of the territorial administrations of the Ministry of Education and Science of the Samara Region (analytical report on the results of the methodological audit of regional centers, Digital Regional Educational Center, Center for Information Technologies);

– design seminars are held with specialists of territorial administrations, regional centers, and school principals (July 6, 2021; July 9, 2021; July 13, 2021; August 2, 2021, etc.);

– professional development programs are implemented for teachers and management teams (https://clck.ru/32VTC6, https://clck.ru/32VTCj, https://clck.ru/32VTDV, https://clck.ru/32VTEA, https://clck.ru/32VTEu, etc.);

– professional development of educators is organized on the basis of the Academy of the Ministry of Education of the Russian Federation.

The data for 2024 are not included in the present analysis, since at the time of the study the monitoring results for the specified period were still at the stage of collecting and verifying primary statistical information. The inclusion of unverified or preliminary data could have reduced the reliability of the conclusions.

Research Sample

Students aged from 15 years 3 months to 16 years 2 months participated in the 2019 and 2022 monitoring, which corresponds to international standards for assessing functional literacy (PISA). In the Russian education system, most students of this age group study in grade 9.

The sampling was carried out on the principles of representativeness: both urban and rural educational institutions of different types (general education schools and specialized secondary schools: gymnasiums, lyceums) were included. This ensured reliability and the possibility of extrapolating the identified patterns to the entire student population of the region and beyond.

Testing periods

Testing in grade 9 was conducted online during the following periods:

– November 27, 2019 – November 29, 2019, total participants: 29,108 students; control sample: 1,200 students;

– October 17, 2022 – October 28, 2022, total participants: 28,521 students; control sample: 2,931 students.

Testing methods

To ensure the possibility of obtaining objective results, diagnostic and assessment procedures in the Samara Region were carried out using the Regional Educational Testing

System (ROST) – the ROST module "Automated Education Resource Management System" (ASU RSO). ROST is designed for creating educational tests, administering testing, and analysing the results obtained from student assessments. This module is integrated into the information systems "Setevoy Gorod. Obrazovanie" (Net City. Education) and "NetSchool".

For diagnostics, PISA-format tasks adapted to the conditions of the Russian digital educational environment were used, in accordance with the "Methodology and Criteria for Assessing the Quality of General Education in General Education Organizations Based on the Practice of International Studies of Student Achievement". This methodology was approved by Order No. 590 of the Federal Service for Supervision in Education and Science and Order No. 219 of the Ministry of Education of the Russian Federation dated May 6, 2019.

All tasks were designed in accordance with the three-component model (Fig. 1):

– context – real-life situations, social interaction, educational process (completing learning tasks using the digital educational environment, developing self-directed learning skills);

– content area – understanding and using information, solving practical problems, communication and collaboration;

– competence area – skills in searching for and processing information, using digital tools for analysis and interpretation, evaluation and adjustment of solutions.

The regional monitoring of functional literacy included three domains: reading literacy, mathematical literacy, and scientific literacy. In the reading literacy block, the context set the reading situation, the content area included the type of text and its structure, and the competence area encompassed types of cognitive activity (searching for information, interpretation, evaluation). In the mathematical and scientific literacy blocks, the context described a real-life or academic problem, the content area included the corresponding subject knowledge, and the competence area involved actions necessary to connect the context with the subject content and arrive at a solution (model selection, data interpretation, evaluation of conclusions).

Each student completed a set of tasks aimed at assessing their ability to apply knowledge in real-life situations.

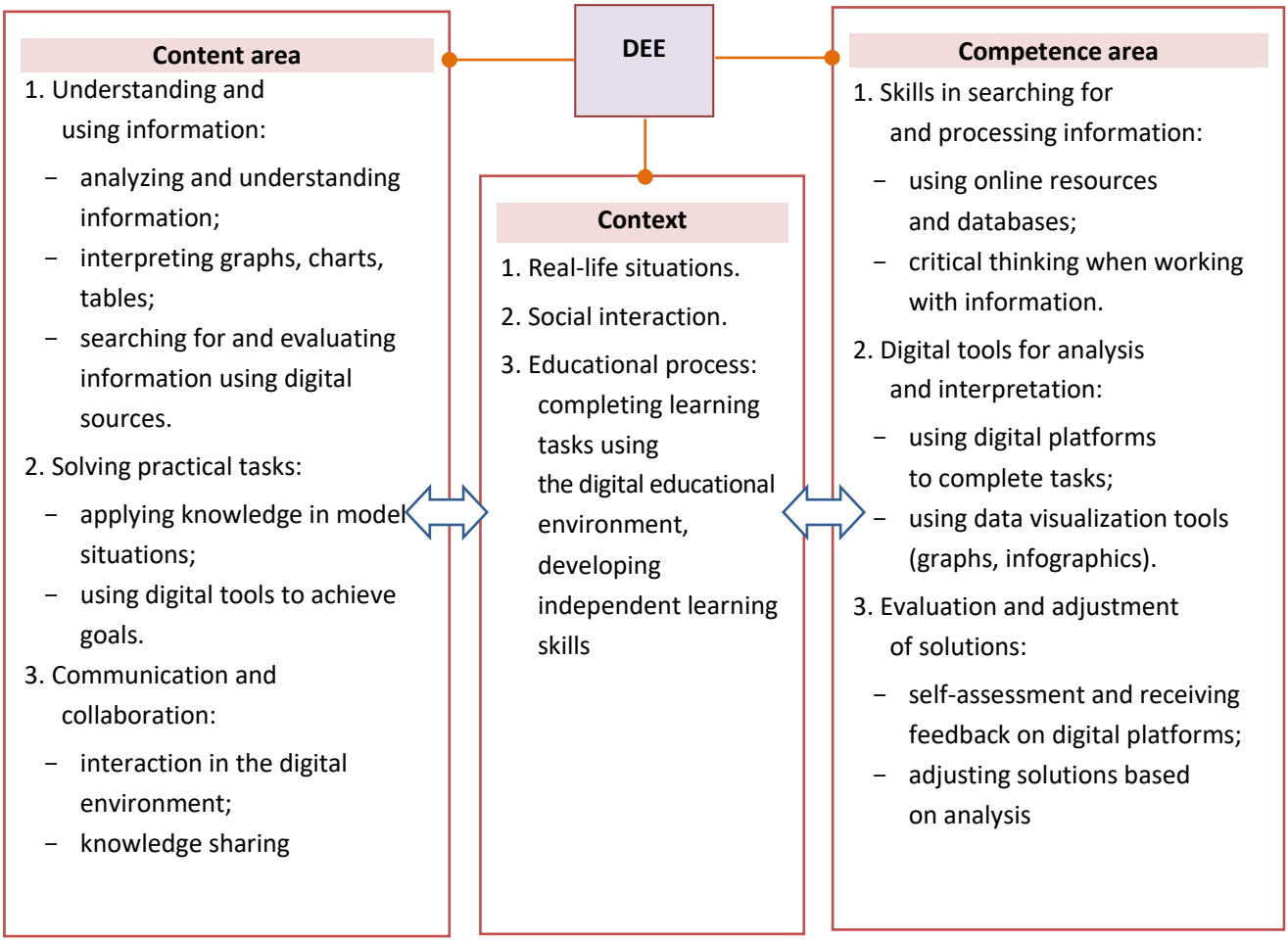

Fig. 1. *Conceptual model for the formation of functional literacy in the digital educational environment*
Рис. 1. *Концептуальная модель формирования функциональной грамотности в цифровой образовательной среде*

Assessment Framework

The total score obtained for all tasks was converted, according to a standard scale, into the level of formation of a particular type of functional literacy. Five levels of functional literacy were distinguished in the study:

1) low – the student demonstrates minimal skills; individual tasks are completed fragmentarily; inability to solve practical tasks independently;

2) below basic – insufficient level of basic skills; some correct actions may occur, but there is no consistency or stability;

3) basic (threshold) – minimally sufficient level for successful learning and participation in social life; ability to solve standard tasks relying on the provided context;

4) proficient – confident mastery of subject-specific and cross-curricular skills; successful solving of more complex tasks; transfer of knowledge to new situations;

5) high – well-developed analytical and critical skills; ability to independently solve complex and non-routine tasks.

The threshold (basic) level is of particular importance, as achieving it is the minimally necessary condition for further successful learning and social adaptation.

Thanks to the use of a scale based on the average indicators of a standardized sample, the task options made it possible to identify students with different levels of functional literacy development.

RESULTS

Conceptual model for the formation of functional literacy in the digital educational environment

The formation of functional literacy in the digital educational environment is considered through the lens of four complementary approaches:

– systemic: the digital educational environment is viewed as a hierarchical, self-organizing system, where integrity is ensured through comprehensive access to content, adaptability through analytical modules, structure through task typology, and hierarchy through levels (individual → grade → school → region);

– competence-based: six domains of functional literacy and their cross-curricular integration are enshrined in the Federal State Educational Standard for General Education (FGOS OO);

– activity-based: knowledge is acquired through solving practical tasks and social interaction;

– digital: digital tools are regarded as mediators between student activity and content.

The introduction of digital technologies and the formation of a unified educational ecosystem in schools and vocational education institutions enable teachers to apply new approaches to teaching, fostering students' independence and analytical thinking. The digital educational environment encompasses a set of digital tools and infrastructure aimed at enhancing the efficiency of learning, improving interaction among participants in the educational process, and ensuring equal access to educational content. The digital educational environment is built on the basis of state and regional information systems, with educational institutions equipped with specialized classrooms furnished with modern technology to provide access. Interaction among participants within the digital environment makes the learning process more flexible and accessible, while also ensuring its effective organization through interactive content and progress monitoring, which ultimately improves the quality of learning and preparation for professional activities (Fig. 1).

The systemic approach to the tasks of the digital educational environment in the educational process implies viewing the digital educational environment as an integrated system, where each element and its functions are interconnected and interdependent, contributing to the achievement of key educational goals.

Access to content can be regarded as a basic function that supports other elements of the system, such as monitoring and participant interaction. This creates an integrated information space in which each student and teacher has access to the resources necessary for effective learning and the achievement of educational goals. This component serves as the foundation for the interaction of all parts of the system and ensures consistency in approaches to learning. The inclusion of functional literacy monitoring systems corresponds to the principles of adaptability and dynamism, allowing for the consideration of individual student results, tracking their progress, and identifying areas that require improvement.

The dynamism of the system is manifested in its ability to update data in a timely manner, generating relevant information about student progress and adjusting educational trajectories based on the obtained results. Digital content on functional literacy becomes an integrated component that is developed and supported by various elements of the digital educational environment, such as interactive tasks and assessment materials.

Let us consider these features using the example of the modules "Global Competencies" and "Creative Thinking", which have appeared in Russian practice relatively recently as separate components of functional literacy. An analysis of regulatory documents shows that the Russian education system is oriented toward achieving unity of goals and requirements, which provides the necessary conditions for the formation of students' global competence. The tasks in this area correspond to the key goals and values formulated in the Federal State Educational Standard of Basic General Education[7]. The assignments are designed with regard to their cognitive, value-based, and activity orientation and are aimed at raising awareness of issues of globalization, sustainable development, and intercultural communication. The subjects of the invariant part of the general education curriculum include the study of these topics, which reflects the integration of global challenges into the educational process. In addition, working with digital platforms enables students to effectively achieve personal educational outcomes, such as "mastery of information skills: the perception and

[7] *On the approval of the Federal State Educational Standard of Basic General Education: Order of the Ministry of Education of the Russian Federation dated May 31, 2021 No. 287. Official publication of legal acts. URL: http://publication.pravo.gov.ru/Document/View/0001202107050027.*

creation of informational texts in various formats, including digital ones, taking into account the purpose of information and its target audience"[8].

The level of development of creative thinking is assessed based on the ability to generate diverse and original ideas, refine, evaluate, and select them. It should be noted that the activation of such cognitive skills as critical, analytical, and creative thinking, as well as the ability to work effectively with information, serves as an important factor in the formation of students' global competence. An approach that includes the development of these skills makes it possible to formulate tasks for fostering global competence and creative thinking more precisely, while also ensuring the opportunity for an objective assessment of achieved results through the use of digital platforms. This, in turn, contributes to the effective application of academic subjects and the implementation of interdisciplinary interaction.

The proposed conceptual model represents an integrated hierarchical framework for developing functional literacy within the regional digital educational environment and fulfills both methodological and operational functions.

Methods and Technologies for Developing Functional Literacy in the Digital Educational Environment

Building on the model described above, the development of functional literacy within the digital educational environment does not occur automatically but requires a targeted approach. This process is implemented through a set of techniques: modelling practical situations, project-based and research activities, and adaptive assessment. During lessons that incorporate digital technologies, practical situations are simulated in which functional literacy skills become both relevant and essential. This approach provides students with opportunities to develop and strengthen their abilities not only during classes and classroom activities but also in the course of project and research work.

Within the framework of the federal project "Digital Educational Environment", schools actively employ digital technologies and tools, creating a universal space for learning. The integration of various educational resources on digital platforms enables a comprehensive approach to the development and assessment of functional literacy, which includes diagnostic procedures, digital content, and a wide range of online tools for the interaction of all participants in the educational process. Particular attention in the context of the digital educational environment is devoted to the implementation of project-based activities and situational tasks aimed at developing functional literacy.

Digital technologies and access to task banks[9] provide students with resources for solving problems aimed at the practical application of knowledge in research and applied activities. The monitoring and assessment systems for functional literacy integrated into the digital educational environment platforms make it possible to effectively track students' level of preparation, promptly identify gaps, and adjust learning trajectories. Students are given the opportunity to solve research and applied problems oriented toward the practical use of knowledge.

To diagnose the level of formation of functional literacy across different domains, it is advisable to use comprehensive tasks in their entirety, as this allows for a more accurate assessment of students' abilities. The tasks for evaluating each component of functional literacy are grouped into thematic blocks (analogous to the PISA study). Each such block represents the description of a real-world problem situation and a series of interconnected questions related to it. In order to complete the tasks, students are required to apply knowledge from various school subjects. The sequential completion of the questions makes it possible to engage more deeply with the given conditions, which contributes not only to the acquisition of new knowledge but also to the development of functional skills.

In the formative component, the use of tasks does not necessarily imply the study of all aspects of a comprehensive assignment – students may be given tasks of varying levels of complexity in accordance with their individual abilities. Teachers have access to a function that allows them to select blocks of questions depending on the results of preliminary diagnostics. The content component of the tasks is presented within a number of subject areas established by the systems (conceptual frameworks) of global and creative competence for school-age students. A portion of the tasks, including versions of diagnostic assessments, has been developed specifically for the organization of school-based monitoring and helps teachers and administrators track the level of development of functional literacy[10]. The open bank of tasks can be used in the educational process in several ways (Table 1).

Tasks placed in open banks can be presented both in digital and paper format. The digital versions are supplemented with interactive elements (external models, audio files, etc.), which expands the possibilities of their application. A distinctive feature of such tasks is their multi-level structure and variability, thanks to which they can perform the function of so-called "transformer tasks." This term

[8] *On the approval of the Federal State Educational Standard of Basic General Education: Order of the Ministry of Education of the Russian Federation dated May 31, 2021 No. 287. Official publication of legal acts. URL: http://publication.pravo.gov.ru/Document/View/0001202107050027.*

[9] *Open banks of the Russian Electronic School. URL: https://fg.resh.edu.ru.*

Federal State Budgetary Scientific Institution "Institute for Content and Teaching Methods". URL: http://skiv.instrao.ru/bank-zadaniy/.

Federal State Budgetary Scientific Institution "Federal Institute for Pedagogical Measurements". URL: https://oge.fipi.ru/bank/.

Prosveshcheniye Media Library. URL: https://dev.media.prosv.ru/fg/.

[10] *Kovaleva G.S., Loginova O.B., ed. Creative Thinking. Methodological Recommendations for the Development of Students' Functional Literacy in Grades 5–9 Using the Open Task Bank on the Digital Platform. Moscow: Institute for Strategy of Education Development, 2021. 119 p. URL: https://www.sev-iro.ru/files/20.10.2022-metodicheskie-rekomendatsii-po-formirovaniyu-kreativnogo-myshleniya-obuchayushchikhsya-5-9-klassov-s-ispolzovaniem-otkrytogo-banka-zadaniy-na-tsifrovoy-platforme.pdf.*

Table 1. *Ways of using open bank tasks in the learning process*
Таблица 1. *Способы использования заданий открытого банка в учебном процессе*

Category	Examples of activities	Goals and objectives	Digital educational environment technologies and resources
Extracurricular activities	"Functional Literacy: Learning for Life"	Developing interest in the subject, fostering practical skills and knowledge	Use of interactive platforms, access to learning materials and tasks
Co-curricular events	Marathons, quests, competitions	Strengthening team spirit, fostering reading, mathematical, financial, and scientific literacy	Platforms for conducting events online (videoconferencing, chats), open task bank
Elective and project courses	Project-based activities, vacation schools	Deepening knowledge within the course, developing research skills	Online platforms for project work, access to digital libraries and interactive courses
Personal development activities	Class meetings, debates, discussions	Developing civic responsibility, critical thinking skills, and social interaction	Digital resources for discussions, resources for simulating situations
In-school monitoring and diagnostics	Testing, diagnostics	Assessing the current level of functional literacy, identifying areas for improvement	Russian Electronic School (RESh), Automated Education Resource Management System (ASU RSO) for automated monitoring and testing

refers to universal tasks that the teacher can flexibly adapt depending on the level of functional literacy formation of students: vary the level of difficulty, change the format of presentation (from basic to extended), and use different contexts. As a result, one and the same task can be transformed and serve as a tool both for basic training and for the in-depth development of students' competencies

Thus, each lesson is supported by the digital educational environment with comprehensive tasks that include texts in various formats along with related assignments, while the main evaluation criterion is mastery of the system of learning activities and the ability to solve learning and problem-solving tasks. The assessed component of competence determines the methods and criteria of evaluation, while the system used allows students to be distributed into groups depending on the degree of their understanding of the issue, rather than solely by the category of their answers. This approach provides a more accurate assessment of the level of material acquisition.

Regional Practice of Using the Digital Educational Environment

In the Samara Region, the development of functional literacy is actively supported through supplementary education. Students are engaged in project activities and mini-research projects, which contribute to the development of their analytical abilities. To foster digital literacy and digital culture, resources of centers established within the framework of the national project "Education" are used, such as the children's technology park "Quantorium – 63 Region"[11], the "IT-Cube" center[12], and the "Tochka Rosta" (Growth Point)[13] education centers.

The children's technology park "Quantorium" has a capacity of 2,000 students, while the mobile technology park "Quantorium" can accommodate 1,100 students. Since 2019, more than 300 "Tochka Rosta" centers have been opened in the Samara region, attended by over 82,000 school students. "Tochka Rosta" centers, established on the basis of rural schools and in small towns, offer training in a wide variety of areas, including:

– Natural sciences – advanced study of physics, chemistry, and biology using modern laboratory equipment (digital sensors, microscopes, robotics kits);

– Technology – programming, basics of robotics, 3D modelling, and work with VR/AR technologies;

– Humanities – media journalism, creation of school television studios, project-based activities;

[11] *Samara Quantorium – a place of remarkable events and vibrant life. URL: https://kvantorium63.orgs.biz/.*

[12] *IT-Cube. Samara Regional Center for Children's and Youth Technical Innovation. URL: https://juntech.ru/podrazdeleniya/it-cube.*

[13] *"Tochka Rosta" Centers. Center for Continuous Professional Development and Pedagogical Excellence. Samara Regional Institute for Education Development. URL: http://master.sipkro.ru/tochka-rosta/.*

– Mathematics – development of logic and algorithmic thinking.

In addition to the federal network of centers, other formats are also actively developing in the region, for example:

– Regional center for identifying, supporting, and developing the abilities and talents of children and youth "Vega" – an analogue of the federal center "Sirius". The center operates in three main areas: science, arts, and sports. It organizes specialized sessions, competitions, and provides support for gifted children;

– Youth Innovation Creativity Center (CMIT) – a network of workshops aimed at supporting technical creativity and small-scale innovative entrepreneurship among young people;

– Specialized competence centers based at colleges and universities in cooperation with "WorldSkills Russia", which serve as training platforms for school and university students in specific professional competencies (for example, Web Design, Network Administration, Graphic Design).

Work is being carried out in the area of cooperation between schools and universities in the Samara Region, where lecturers, professors, and students organize clubs and elective courses for schoolchildren.

Samara University holds an annual Open Day for school students with tours and master classes[14], and also annually organizes or takes part in organizing school Olympiads (academic competitions). In the 2025–2026 season, 23 Olympiads[15] are being held with its participation.

In Samara, the supplementary engineering education system includes the Children's Technical School "Engineering Power", which offers programs for children aged 7 to 12 (grades 1–5). The programs aim to develop a systemic polytechnic worldview and engineering thinking in primary school children. The "Engineering Power" Technical School teaches computer literacy, programming, construction, design, and project-based activities[16].

"School for Mentors" is a project that has been implemented at Togliatti State University since 2022 as part of student project activities. The aim of the project is to broaden the proactive outlook of school students, provide training in mentoring, and develop and implement new pedagogical methods.

Some of the project's activities include:

– "Pedagogical Holidays" – a pre-professional educational intensive program for school students;

– "MentorFEST: School Project" – an annual regional competition.

"MentorFEST" serves as a platform for demonstrating students' creative potential, research skills, and teamwork abilities. In 2025, the competition featured five sections: "Pedagogy", "Technical and Natural Science Creativity", "Journalism and Sociology", "Foreign Language", and "History and Regional Studies"[17].

The set of activities covers both the school and vocational education levels (Table 2). At the school level, all general education institutions have introduced the extracurricular course "Functional Literacy: Learning for Life", which enables students to integrate the skills necessary for the effective application of knowledge in everyday life[18]. At the level of secondary vocational education, the curriculum of the discipline "General Competencies of a Professional" has incorporated the thematic module "Functional Literacy", aimed at developing applied skills in demand in professional activities. The implementation of these activities actively employs modern technologies and information systems.

Results of the Empirical Study

A comparative analysis of the 2019 and 2022 monitoring results shows that 15–16-year-old students in the region have significantly increased their level of functional literacy (Fig. 2).

The 2019 regional monitoring revealed the following results: a low level was identified in 60.7 % of the tested students; below basic – 19.5 %; basic (threshold) – 15.5 %; proficient – 4.3 %; and high – 0 %, with no student reaching this level.

The analysis of the 2019 regional monitoring data showed that the vast majority of students (80.2 %) demonstrated a level of functional literacy below the basic threshold: 60.7 % of students had a low level, and another 19.5 % had a below-basic level. In other words, more than four-fifths of the tested students in 2019 did not possess the minimally necessary set of competencies for effectively addressing real-world tasks and challenges. The absence of students at the high level indicates that the existing educational system was not only unable to ensure mass quality but also incapable of identifying and developing talented students capable of complex, creative, and non-standard solutions within the framework of functional literacy.

The 2022 regional monitoring revealed the following results: low level – 4.3 %; below basic – 35.6 %; basic (threshold) – 42.1 %; proficient – 17.7 %; high – 0.3 % (Fig. 2).

There is an evident radical change in the distribution structure of students. While in 2019 a critically low level dominated (60.7 %), by 2022 the majority of students (42.1 %) were concentrated at the basic (threshold) level, indicating mass acquisition of the minimally necessary competencies. The system has shifted from a state of crisis to a state of stability. However, despite these obvious improvements, only 18 % of students in total demonstrate levels above basic. This highlights the need for continued

[14] *Open Days. Samara University. URL: https://ssau.ru/priem/school/dod.*

[15] *Olympiads of Samara National Research University named after Academician S.P. Korolev. Apply Online. URL: https://samara.postupi.online/vuz/samarskij-universitet/olimp-list/.*

[16] *Children's Technical School "Engineering Power". Engineering Power. URL: https://shkola.insila.ru/o-nas/.*

[17] *TSU Recognized the Best School Projects. Togliatti State University. URL: https://www.tltsu.ru/news/v_tgu_otmetili_lucsie_skolnye_proekty.*

[18] *Functional Literacy: Learning for Life (Basic General Education). Moscow: Institute for Strategy of Education Development, 2022. 137 p. URL: https://edsoo.ru/wp-content/uploads/2023/08/ВУД_Программа-курса-внеурочной-деятельности.-Функциональная-грамотность-ООО_Новая.pdf.*

Table 2. *Digital educational environment of the Samara Region in the context of activities for developing functional literacy*
Таблица 2. *Цифровая образовательная среда Самарской области в контексте мероприятий по формированию функциональной грамотности*

Activities for developing functional literacy	Description
Course "Functional Literacy"	"Prosveshchenie" media library
Module in Secondary Vocational Education	Electronic bank of practice tasks
Regional monitoring	Russian Electronic School (RESh)
Testing on the task bank platform	Integration into ASU RSO
Diagnostic tasks in functional literacy	Access to educational resources
Seminars for educators	Methodological support for educators
Provision of teaching materials	Automation of monitoring
Extracurricular courses	Support for assessment and analysis of results

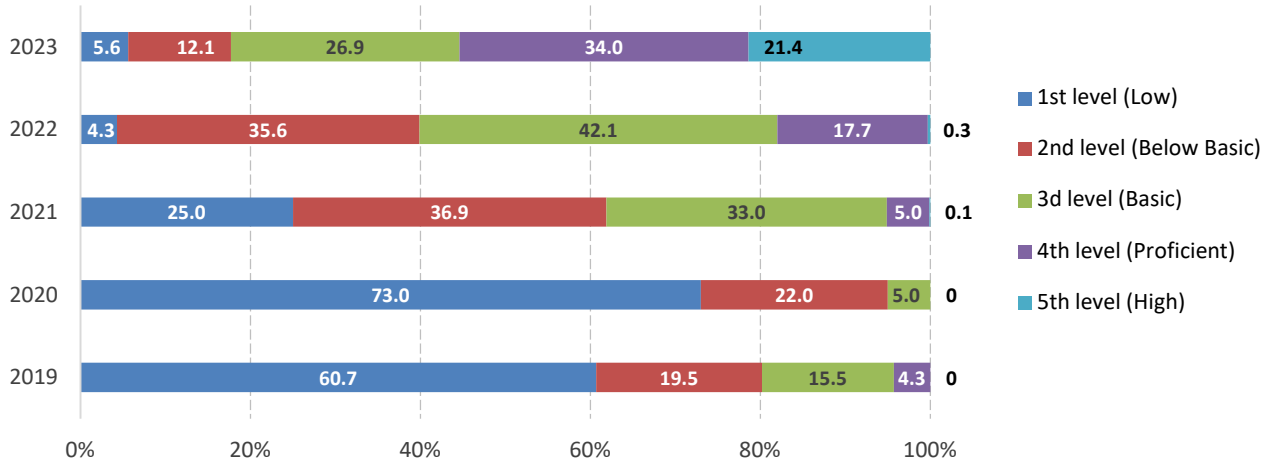

Fig. 2. *Results of the regional monitoring of functional literacy in the Samara Region, 2019–2023*
Рис. 2. *Результаты регионального мониторинга функциональной грамотности в Самарской области в 2019–2023 гг.*

efforts in individualized learning, the development of creative thinking, and advanced forms of information processing.

DISCUSSION

The study results convincingly demonstrate that the implementation of a digital educational environment, which provides access to interactive materials, testing systems, and digital content, expands opportunities for developing students' functional literacy, contributing to the enhancement of the competencies necessary in the modern world. Since 2019, the functional literacy level of students in the Samara Region has steadily increased, with the exception of 2020 (Fig. 2). The decline in functional literacy in 2020 can likely be attributed to the challenges associated with COVID-19 pandemic restrictions. The school system endured the COVID-19 pandemic but faced a number of difficulties that required adaptation to distance learning. The pandemic disrupted the functioning of educational systems, primarily due to the inability to organize full-fledged distance learning because of internet limitations in remote areas and problems with students' technical equipment. Insufficient technical preparedness of the teaching staff was also observed: the transition to a remote format was sudden, and neither educators nor students were ready for it. However, research [15] indicates that the decline in students' academic performance may have a multifactorial nature.

Alongside the two-year period of the coronavirus pandemic, the rapid development of information and communication technologies worldwide at the turn of the 2010s also had a significant impact. Theoretical analysis confirms that active use of digital technologies in the educational process correlates with certain cognitive changes. Empirical data indicate a decline in memory quality, attention span, the ability to work with complex texts, and mental arithmetic [16–18]. The emergence of fragmented (clip-based) thinking and the reduction in the volume of fundamental knowledge create systemic conditions for a sustained decrease in performance in international assessments of educational quality, such as PISA [8–10].

Conducting testing and regional monitoring is a significant component in the development of functional literacy. The platform of the electronic training task bank provides regular assessment of students' functional literacy levels, allowing for objective testing and real-time tracking of results. The same goal is supported by diagnostic tasks conducted through the automated system "Russian Electronic School" (RESh). According to the authors [19], regional monitoring can serve as a tool for coordinating educational changes in situations where textbooks and manuals do not contain a sufficient number of complex contextual tasks, and curricula across different subjects remain fragmented. Such monitoring creates a space for interaction among teachers and helps identify deficits that hinder the functional mastery of subjects. A key requirement is that monitoring be conducted without stress – that is, without the status of a formal exam, without impact on students' final grades, and without punitive measures against educators. Only under these conditions, and with recognition of the importance of the results by the education community, can the concept of functional literacy acquire practical meaning through discussions, experimental modules, and new lesson formats [19].

However, the effective implementation of digital tools faces a significant methodological challenge. The main barrier to achieving innovative effects in a digitally enhanced educational environment is the so-called third digital divide [11]. This phenomenon manifests in educators transferring traditional teaching methods into the new digital educational reality without a substantial revision of their methodological foundations. Instead of transforming the educational process in accordance with the potential of digital technologies, there is a mechanical adaptation of familiar pedagogical approaches, which limits the possibility of realizing the innovative potential of the digital environment. This methodological divide hinders the formation of a new educational paradigm necessary for preparing individuals to live in a digital world [12].

The regional digital educational environment plays a crucial role in the development of functional literacy, providing educators and students with access to educational resources, supporting the assessment and analysis of results through automated testing systems, and enabling teachers and educational institutions to access up-to-date instructional materials. Successful development of functional literacy is possible only when the actions of school leadership, educators, and parents are coordinated, and when students themselves possess the necessary psychological readiness [20]. Thus, the regional digital educational environment facilitates the achievement of targeted educational objectives, ensures a unified approach to developing functional literacy, and allows for rapid adaptation to the requirements of educational standards and regulations.

The positive dynamics observed in the annual monitoring of the functional literacy level of students in the Samara Region demonstrate that the targeted use of the regional digital educational environment is a powerful tool for personalizing learning and developing practice-oriented competencies. The current objective is shifting from "eliminating lag" to "ensuring advanced development," focusing on increasing the proportion of students achieving higher levels, which represents the ultimate goal of preparing a competitive individual in the modern world.

The prospects for the development and use of the regional digital educational environment in the Samara Region are seen in the transition from merely addressing the tasks of diagnosing and developing functional literacy to creating an integrated digital educational system that ensures the advanced preparation of students for contemporary challenges. The accumulated datasets on the dynamics of each student's educational outcomes within the digital educational environment enable predictive analytics, the construction of individualized developmental trajectories, and the automated selection of corrective educational materials. Another current task is the creation and continuous updating of a library of digital educational content (cases, simulators, project-based tasks) that integrates the regional component, including the economy, ecology, and culture of the Samara Region. The development of the digital educational environment will be ineffective without targeted work with educators. In the future, the establishment of a system of methods aimed at enabling educators to master digital tools for creating individualized educational ecosystems for students is anticipated. Thus, the prospective development of the digital educational environment in the Samara Region is connected not only with expanding technological capabilities but also with profound pedagogical transformation, centered on personalization, advanced analytics, and the creation of relevant digital educational content.

CONCLUSIONS

1. Annual regional monitoring of functional literacy demonstrated that by 2022 the share of students with proficient and high levels of functional literacy increased to 18 % compared to 4.3 % in 2019; thus, over four years this indicator improved more than fourfold. A significant outcome was the emergence, in 2022, of students with outstanding results (0.3 %), indicating the creation of conditions for students to progress to a higher level of functional literacy.

2. A regional model was proposed, establishing an integrated cycle of "context – content – competency domain," uniting six areas of functional literacy with the capabilities of the Automated Education Resource Management System (ASU RSO, ROST module); the effectiveness of the proposed model has been empirically confirmed. The implementation of a digital educational environment, providing access to interactive materials, testing systems, and digital

content, expands opportunities for developing students' functional literacy, contributing to the continuous enhancement of competencies required in modern society.

3. The analysis of the effectiveness of implementing the digital educational environment demonstrated the importance of the regional component for the development of functional literacy, as well as for creating a personalized and flexible educational space that supports the achievement of educational objectives.

4. The prospects for developing the digital educational environment in the Samara Region are associated with the transition from mere diagnostics to a system of advanced preparation based on predictive analytics, the creation of up-to-date digital content with a regional component, and systematic training of educators to work in new conditions. Further development is determined not only by technological capabilities but also by the depth of pedagogical transformation toward personalized education.

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УДК 37.013
doi: 10.18323/3034-2996-2025-3-62-1

Региональная модель формирования функциональной грамотности в цифровой образовательной среде: концепция, апробация и оценка эффективности

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Поступила в редакцию 20.05.2025 *Пересмотрена 29.07.2025* *Принята к публикации 11.09.2025*

Аннотация: Цивилизационный переход порождает объективную потребность общества в формировании функциональной грамотности как ключевого фактора национальной безопасности и индивидуальной успешности. В ответ на эту потребность предлагается динамическая и адаптивная модель формирования функциональной грамотности. Ее ключевое преимущество – способность интегрировать актуальный региональный контекст и гибко реагировать на

вызовы нестабильности и высокую скорость социокультурных изменений. Исследована роль цифровой образовательной среды (ЦОС) региона в формировании функциональной грамотности у школьников (на примере Самарской области). Результаты мониторинга сформированности функциональной грамотности учащихся образовательных учреждений, проведенного в 2019 г., показали недостаточный уровень развития глобальных компетенций и креативного мышления. В целях решения проблемы были использованы возможности ЦОС региона для повышения качества образования: учащихся образовательных учреждений Самарской области вовлекали в проектную деятельность, развивали их аналитические способности, предлагали решать контекстные задачи, моделирующие реальные ситуации. Были активно задействованы ресурсы региональной системы дополнительного образования. В течение четырех лет ежегодно отслеживались результаты работы, которые показали, что к 2022 г. доля учащихся с высокими результатами выросла до 60 % по сравнению с 2019 г. (19,8 %), другими словами, показатель улучшился более чем втрое. Это позволило сделать вывод о положительных перспективах использования ЦОС для создания многофункциональной образовательной среды региона, развивающей личностные и учебные компетенции. Ключевой перспективой исследования является переход от эпизодического мониторинга к системе непрерывного формирующего оценивания на основе ЦОС, что позволит в режиме, близком к реальному времени, собирать и анализировать образовательные результаты на всех уровнях системы (от отдельного школьника до муниципалитета) для оперативной корректировки образовательного процесса.

Ключевые слова: функциональная грамотность; цифровая образовательная среда региона; ЦОС; глобальные компетенции; креативное мышление; концептуальная модель; информационные системы; мониторинг учебных достижений; цифровые технологии в образовании.

Для цитирования: Акопьян В.А. Региональная модель формирования функциональной грамотности в цифровой образовательной среде: концепция, апробация и оценка эффективности // Доказательная педагогика, психология. 2025. № 3. С. 11–23. DOI: 10.18323/3034-2996-2025-3-62-1.