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Researching the Potential of Interactive Timelines for the Development of Schoolchildren's Creative Thinking in Additional Education

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Abstract

One of the most important tasks facing a digital school teacher is to prepare a school leaver who is able to use the acquired knowledge in further life and generate new ideas, offer non-standard solutions, go beyond the usual patterns and circumstances. The authors investigate the problem of substantiating the effectiveness of using timeline services for the development of schoolchildren's creative thinking in additional education.

The purpose of the study is to research the didactic potential of interactive timelines in the additional education classroom for the development of schoolchildren's creative thinking.

The methodology is based on identifying the possibilities of additional education and technologies of the university's digital environment for the formation of creative thinking components; on clarifying the study program and methods of organizing activities in studios when creating time lines. The experimental work was carried out in studios for speech development, photo and video art. The Timeline JS service is used to create timelines.

The results show the study program, methods of organizing activities in studios when creating timelines: displaying facts in chronological order, compiling algorithms, creating biographies, and presenting statistics. Difficulties that complicate the use of services are also formulated: management of temporary resources, the need to develop criteria and indicators of the effective use of web applications of corresponding designation. The results obtained can be used in additional education classes for career guidance, free time organization and support of schoolchildren's intellectual development.

Keywords: content of education, information interaction, digital technologies, creativity indicators, intellectual development, time scale, Timeline JS.

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1. Introduction

The Club of Rome Report presenting the conclusions made by the analytical center "Development Alternatives", which together with experts from the United Nations deals with issues of sustainable development, has determined that one of the tasks of modern education is to form problem-solving abilities in all students, as well as critical, independent and original thinking skills ([Doklady Rimskogo Kluba, 2023](#)). According to A. Dilekci, H. Karatay, a drastic refocusing of the content of education presume ([Dilekci, Karatay, 2023](#)): transferring knowledge gained on the basis of past experience; expanding the areas of knowledge, skills and capabilities that will be required in the future; adaptation and creative response to those uncertain conditions and challenges that are only envisaged.

According to D.E. Dobrinskaya, the processes of globalization and digitalization of society presuppose the development of an integrated educational space in the world ([Dobrinskaya, 2021](#)). Globalization of education has the following aspects: the general growth of the importance of knowledge, the introduction of information and communication technologies, etc. These aspects are catalysts for new forms of providing education (distance, virtual, mixed, etc.). There is an increase in the mobility of both participants of educational relations and training programs.

Many didactic projects may go beyond educational institutions, cities and countries, e.g. the project "Advanced Engineering Schools", launched in 2022 on the initiative of the Ministry of Science and Higher Education of the Russian Federation ([Proekt..., 2023](#)). The conditions for its implementation involve cooperation between representatives of economic structures, teachers of universities and schools from different countries. Project directions are development of high-tech industries, support for creative students who are not afraid to experiment. The project program provides interactive training complexes, networking, participation in brainstorming sessions, etc.

Thus, the vector for integrating the work of the school and the university to train qualified engineering personnel of the future is determined at the federal level. In addition, as M.I. Bocharov, T.N. Mozharova, E.V. Soboleva, T.N. Suvorova note that the role and importance of such a skill as "self-education and self-improvement throughout life" increase in modern education ([Bocharov et al., 2021](#)). So, the digital society requires such personal qualities that would help to solve quickly, unconventionally and effectively problems facing the society in the new millennium.

The Ministry of Education of Russia within the framework of the national project "Education" launches a federal project "Success of every child" ([Ministerstvo prosveshcheniya..., 2023](#)). According to its requirements, 80 % of teenagers should be engaged in additional education by 2024. In particular, there should be:

- Updating the content of additional education in all areas;
- Improving the quality and variability of educational programs;
- Transferring training programs into a network format (according to the interests of children with different educational needs);
- Improving the infrastructure and professional skills of teaching/managerial personnel.

The Conception of the development of additional education for children until 2030 also focuses on the development of creative abilities of students; on the individualization of education, taking into account the interests and inclinations for a particular creative activity ([Kontsepciya razvitiya..., 2023](#)).

Social Internet services, according to the conclusions of N.Ya. Ageev, Yu.A. Tokarchuk, A.M. Tokarchuk, E.V. Gavrilova, when used in education are universal, interdisciplinary in nature ([Ageev et al., 2023](#)). But naturally, the technological features of some services are better implemented in teaching a single subject (history, geography, computer science) or a specific topic (the history of computer development). The corresponding areas of applying services for working with timelines, of course, represent a certain didactic potential for the including relevant timeline constructors in various forms of additional education.

However, as noted by S.Yu. Stepanov, I.V. Ryabova, E.V. Gavrilova, very significant risks in terms of the development of thinking are associated with the spread of new digital technologies, web services and screen gadgets. They are used by teenagers mainly for entertainment, leisure activities ([Stepanov et al., 2021](#)). According to scientists, the earlier a child starts using digital devices, the severer the consequences for the formation of higher mental functions may be: delays in the development of speech, attention, memory and thinking.

This begins to affect the ability and readiness for learning, for self-development, as well as for creative activity especially strongly in school years. At the same time, as E.N. Malova,

V.G. Shubovich, M.M. Shubovich show, if digital means are used moderately and taking into account the requirements (norms) of the Sanitary Regulations and Norms for developmental and educational purposes, then it is possible to create additional didactic opportunities in terms of the formation and development of higher mental functions in the younger generation (Malova et al., 2019).

The hypothesis of the study is that including schoolchildren's work with online timeline services in the program of additional education classes will contribute to the creative development of students if the features and structure of this type of thinking, the possibilities of additional education and information technologies of the digital environment for the formation of creativity components are taken into account.

2. Relevance

2.1. Literature review

2.1.1. Analysis of Russian scientific and pedagogical literature

The result of creative thinking, according to Ya.A. Ponomarev, is new discoveries, and sometimes works of art (Ponomarev, 1976). Creative thinking involves generation of qualitatively new or improvement of existing solutions to the problem. D.B. Bogoyavlenskaya proposes to single out intellectual activity as a unit for research creativity (Bogoyavlenskaya, 2002). A creative person, according to E.P. Ilyin, is usually the one who has committed an act (mental or activity), which was highly appreciated by the majority (Ilyin, 2009).

B.M. Velichkovsky, G.G. Knyazev, E.A. Valueva, D.V. Ushakov determine originality, flexibility of thinking, independence, activity, initiative as qualities of a creative personality (Velichkovsky et al., 2019). Creative thinking is also the subject of teachers' study, mainly in relation to the learning process. The pedagogical aspect of creativity, according to the justification of M.N. Dolgikh, N.N. Dolgikh, does not imply the creation of a significant (marketable) product itself. Its function is monitoring the success of competencies development and training the components of the competence acquired. According to S. H. Khaknazarov, in the modern digital educational environment, the "education – teaching" model should be replaced by the "education – interaction" model (Dolgikh, Dolgikh, 2019). As S.Yu. Stepanov, I.V. Ryabova, E.V. Gavrilova conclude, due to the changed strategy in the Russian education system, it is necessary to revise approaches to teaching children in specific educational institutions (Stepanov et al., 2021).

S.S. Bykova, I.B. Buyanova, L.A. Serikova propose to carry out systematic work to identify creative, non-standard thinking students using TIPS technology (Bykova et al., 2020). The authors attribute the following to the peculiarities of adolescents' creative thinking: the possibility of distraction from specific situations, the ability to generate original ideas; the ability to predict the desired result; to anticipate the consequences of their decisions. Scientists suggest to include a system of methods in the training program: method of focal objects; brainstorming; Robinson Crusoe method; role-setting; the ideal end result.

E.V. Soboleva, T.N. Suvorova, N.Y. Blokhina, E.L. Batakova describe the possibilities of "virtual walls" for the formation of group creative thinking (Soboleva et al., 2021). The authors note that virtual communication, online collaboration, work with digital objects, the use of software and hardware has become an obligatory element of modern (including additional) education. Scientists prove that such interactive resources contribute to a comprehensive study of the object (search for information, presentation, creative processing, author's presentation, establishing relationships); collective creativity; evaluation of the result obtained from the position of its application in qualitatively different conditions (in the future).

According to S.Kh. Khaknazarov, additional education is an important socializing factor today, ensuring the productive use of schoolchildren's free time, as well as direct career guidance work for their intellectual development (Khaknazarov, 2022). Yu.A. Karvunis, M.B. Lozhkina, L.V. Kapilevich explore the possibilities of using e-learning elements in additional education of children on the example of sports and tourism programs. They come to the conclusion that the principle of mixed learning is at the heart of such forms of work: modern technologies make it possible to increase the effectiveness of schoolchildren's intellectual development due to greater visualization of the material (Karvunis et al., 2021). For example, the content of concepts is enriched, the student learns to distinguish essential and secondary features, to notice the connections and relationships between them, etc. According to the authors' conclusions, working with interactive maps and local history information in an electronic environment in all age groups

contributes to the improvement of generalized results in the areas of search and research, project and creative activities.

V.V. Uranova, O.V. Bliznyak, M.V. Mazhitova, R.R. Isyakayeva prove that a timeline can become an effective tool for creating an effective, attractive "packaging" of educational material. This is a graphical interactive scale that contains labels with information about an event, process, phenomenon in chronological order. They describe digital timeline as a web application that is designed to view, create, edit and publish interactive graphical timelines (Uranova et al., 2022).

M.E. Manshin, O.A. Kazanchyan note that there is a large number of software complexes for creating and editing chronological lines designed for both business and school and student audiences. The authors conclude that the use of a timeline when studying a writer's biography in literature lessons is the optimal means of activating interest in the author's personality among schoolchildren. Creating tapes in a specialized program simplifies the process and contributes to the development of ICT competencies, which is an indispensable criterion for modern education (Manshin, Kazanchyan, 2019).

A.V. Dikov highlights the following possibilities for using timelines in the pedagogical process (Dikov, 2016):

- Online familiarization with events on a public line for analysis and a holistic view of the studied phenomenon;
- Creation of tapes with the results of research within the framework of project activities;
- Using timelines as a task for independent work of pupils.

Unfortunately, the author does not note the potential for applying timelines to develop creative thinking.

At the same time, according to the conclusions of K. S. Chitailo, the use of information technologies in additional education determines new forms, methods of activity in classes and new options for interaction between teachers and schoolchildren (Chitailo, 2021).

Thus, using a timeline allows you to get a visual history of the development of a process. Events can be presented in the form of a text, pictures, video and audio recordings. When describing events on the timeline, it is enough to simply insert a hyperlink to Internet resources related to the fact, discovery. In other words, there are new opportunities that have a certain potential for the development of students' thinking. The specifics of additional education, in turn, make it possible to create conditions for the formation of self-awareness, self-determination and self-realization of the child. Moreover, the process of socialization is mediated by creativity, creative activity in the team. It has its own logic of development, involves overcoming and removing contradictions. This means that it can, when designing certain pedagogical conditions, contribute to the adaptation of the students' personality, the development of their creative abilities.

Thus, the following facts were revealed during the analysis:

- The presence of formed creative thinking is an important universal personality skill (Dolgikh, Dolgikh, 2019);
- Digital technologies with interactive capabilities have the potential for the development of creative thinking (Soboleva et al., 2021);
- Timelines are actively used for school education, to activate information interaction (Chitailo, 2021);

However, Russian scientific and pedagogical works devoted to identifying the possibilities of time scales to support the processes of generating ideas, improving the existing solutions to the problem are clearly not enough.

2.1.2. Analysis of foreign studies

M. Durnali, Ş. Orakci, T. Khalil conclude that manifesting creative thinking is inextricably linked with the intensity of emotional characteristics (Durnali et al., 2022). The authors note that combining the concepts "intelligence" and "emotions" raises controversial issues, which is quite natural for the scientific branch of knowledge. But at the same time, these issues require discussion, especially when it comes to the education system.

S. Lee, J. Kenworthy, P. Paulus define that creativity (as a synonym for creative work) is a mental ability and inclination to generate new ideas and products that have a specific purpose, utility or value (Lee et al., 2022). The authors conclude that at the present stage of the development of psychological and pedagogical knowledge, there is a conscious need to identify the essential characteristics of the cognition process in various learning models, the determining factor in which is an increase in the level

of creativity. Further S. Lee, J. Kenworthy, P. Paulus substantiates that the effectiveness of the educational process increases if you include elements of humor. Humor lowers the level of tension. According to the results of their research, generation and perception of humor is an intellectual activity. In addition, the process of cognition based on humor proceeds through the resolution of contradictions and is mediated by intellectual activity (Lee et al., 2022). That, in general, as scientists conclude, creates conditions for the effective training individual creativity based on humor.

According to J. Guilford, creative thinking is conditioned by the formation and expression of four characteristics: fluency, flexibility, productivity and complexity (degree of development) (Guilford, 1956).

According to Th. Hardman's conclusions, the creative process (in art, business or science) includes both intellectual, conscious thinking processes and less conscious intuitive processes of cognition and discovery (Hardman, 2021). In creative activity, logical methods and strategies for solving problems interact with intuitive thinking mechanisms, mutually reinforcing each other. The power of the human psyche lies precisely in the fact that all forms of human reflection of reality (imagination, memory, different levels of thinking, etc.) coexist in close unity and complement each other.

Y. Görlich develops the author's scale of evaluation of the creative process: problem detection; search and evaluation of information; combination of concepts; generation of ideas; determination of the approach to the solution; evaluation of the idea; adaptation and implementation; communication and fulfillment (Görlich, 2023).

A. Dilekci and H. Karatay investigate the impact of an educational program developed in accordance with the "skills of the 21st century" on the development of such indicators of creative thinking as flexibility and originality (Dilekci, Karatay, 2023). According to their conclusions, creative thinking skills can be developed if there are appropriate conditions. Many people, according to L.S. Colzato, S.M. Ritter, L. Steenbergen, are not aware of their own creativity, because there is no suitable environment for its manifestation (Colzato et al., 2018).

Ü. Avcı and H. Yildiz-Durak study the factors influencing the development of creative and innovative thinking in the educational environment. In particular, scientists investigate internal and external motivation, learning goals, academic success (Avcı, Yildiz-Durak, 2023). L. Azaryahu et al. describe the possibilities for developing creative thinking in music and mathematics classes (Azaryahu et al., 2022). When developing new teaching methods and activities, the authors describe didactic resources that contribute to the formation of schoolchildren's positive attitude to the study of theoretical facts. For example, tasks on association, improvisation and composition.

B. Bridglall, E. Gordon in their study describe the essence of additional education and emphasize that general education develops as formal (it has a standard) one, and additional develops as informal (beyond the standard) one (Bridglall, Gordon, 2002). At the same time, today both general and additional education acquires formal and informal features. The authors point out that the principle of "availability of additional education for children" is not fulfilled for many families. But at the same time, it is additional education, according to J.B. Carroll, J. Goodwin, M.K. Oliver, that promotes academic, civic and social success to children from such families. In the conditions of additional education, children get the opportunity for creativity and self-expression, "going beyond" the social environment (Carroll et al., 2007).

According to the conclusions of X. Zhao, J. Yang, family, relationships between parents and parenting styles in the family play an important role in the development of creative thinking of the individual (Zhao, Yang, 2021). Its formation, a person's readiness for creativity are important conditions for the competitiveness of future graduates, skills of political importance.

Y. Wang et al. discuss at a more scientific and technical level the potential of computer visualization tools to increase visibility using the example of research projects in industry (Wang et al., 2022). With regard to education, similar conclusions are contained in the work of G. Zhang et al. (Zhang et al., 2022) Scientists conclude that in the framework of e-learning, the information presented is multimedia: text, images and video. The data itself display a variety of events, facts. But they do not allow to convey the dynamics, cause-and-effect relationships between them. This creates problems for correlating, comparing information from different sources to obtain valid conclusions. To solve this problem, special web analytics tools are to be used. R. Archana offers to use interactive tools of the information environment for the development of creative and artistic thinking. In particular, she considers digital art, the use of computer graphics tools (Archana, 2018).

Digital art, according to the author, can be defined as art that explores computer, engineering technologies and digitally encoded information content as a tool and material for creativity.

S. Bagossi, O. Swidan, F. Arzarello consider timeline possibilities in mathematical training for schoolchildren in Italy and Israel. Service tools are identified to activate information interaction when working with graphs and diagrams. However, the potential of time scales remains hidden, taking into account the specifics of additional education (Bagossi et al., 2022).

Such components of pedagogical activity, of course, suggest going beyond the class-and-lesson system. So, the analysis of the above-mentioned scientific works of foreign researchers also allows us to identify:

- Development of pupils creative thinking is an objective necessity due to the challenges of modern digital society to the level of training of graduates (Dilekci, Karatay, 2023);
- Timelines as a part of additional education give further opportunities for creating creativity (Bridglall, Gordon, 2002);
- Interactive services, computer visualization tools have powerful didactic potential for the development of creative thinking (Wang et al., 2022);
- Timelines are also interactive multimedia. However, the number of works devoted to their use to support the creative expression of schoolchildren is clearly not enough (Bagossi et al., 2022).

Thus, there is an objective scientific problem associated with the necessity for additional study of the development of schoolchildren's creative thinking in the conditions of additional education when working with timelines.

2.2. Purposes and objectives of the study

The purpose of the study is determined by the need to study the didactic potential of online services for working with timelines in the additional education classrooms for the development of schoolchildren's creative thinking.

The following tasks were identified as the main ones:

- To identify the factors influencing the development of schoolchildren's creative thinking in additional education when working with online timeline services;
- To clarify the didactic potential of the information educational environment of the university in terms of forming the components of creativity: fluency, flexibility, productivity and complexity (development);
- To develop a program of classes and methods for organizing activities in studios when creating timelines.
- To experimentally test the effectiveness of the proposed system of classes on working with interactive timelines in additional education.

3. Materials and methods

3.1. Theoretical and empirical methods

To achieve the goal and solve the research tasks, theoretical analysis and generalization of literature were used to identify problems and prospects for using timeline services in conditions of additional education, to clarify the didactic potential of digital technologies for the formation of creative thinking.

A timeline is a time scale on which labels with data about the event, process, or phenomenon are placed in chronological order. Digital services for timelines analyzed were: StoryMap JS, Tiki-Toki, Sutori, Timeglider, Preceden, MyHistro, SmartDraw, Timeline JS. Comparison criteria included: information about developers, the year of release, paid/free, the option to choose the Russian language for the interface, the convenience and clarity of the registration form, functionality and principles of operation (working with Russian text, the ability to download graphics and videos, the form of saving: publication on the service/publication on any site). Timeline JS was chosen for detailed study and practical application in additional education. Its advantages are:

- The service is free, simple and multi-purpose and allows you to incorporate the result into the page of any website;
- The service "creates" a timeline based on the Google table;
- The information can be accompanied by a link to a photo, video or a code, for example, to a map or infographic;
- By clicking "Open Preview in a new window", the timeline will open in a new window. This link can be distributed, for example, on social networks.

Experimental work was carried out on the basis of studios: the speech development studio «In the know» and the studio for photo and video art «Perspective», involving 60 schoolchildren. The study was conducted in 2021–2023.

To diagnose and assess the formation of creative thinking, the method "Divergent (creative) Thinking Test" was used. The author is F. Williams (adapted by E. E. Tunic). This is a series of drawing tests revealing the student's creative self-expression abilities according to the following indicators: fluency of thinking (productivity), flexibility of thinking (mobility), originality, degree of development, naming (richness of vocabulary and imagery of speech). These indicators correspond to the essence of creative thinking according to J. Gilford: fluency, flexibility, productivity and complexity (degree of development).

To collect of experimental data, the test with a duration of 25 minutes was carried out twice: at the beginning of the lesson system and after it. Scoring was performed after familiarization with the methodology and instructions.

Five indicators were evaluated: fluency (maximum score – 12); flexibility (maximum score – 11); originality (maximum score – 36); development (maximum score – 36); name (maximum score – 36). The procedure is presented in detail in clause 4.3.1.

Mathematical methods: methods of quantitative processing of research results; methods of mathematical statistics (Pearson's chi-square coefficient – χ^2).

3.2. The base of research

The main purpose of the experimental work was to test the effectiveness of using online services to create timelines for the development of schoolchildren's creative thinking in additional education.

The use of timeline services within the framework of experimental search work for the development of creative thinking was carried out during classes: in the speech development studio «In the know» (guidance – K.A. Chaplygin, N.Yu. Kryuchkova) and in the studio for photo and video art «Perspective» (N.I. Zhukova).

The choice of these studios is due to the fact that they operate on the basis of Vyatka State University. E.V. Soboleva as a teacher of the university oversees the introduction of digital technologies into the pedagogical activities of specialists in the additional education system.

Possible external variables for the experiment: material and technical base, motivation and mood of the pupils, parental consent, experience and qualification of the studio manager, duration and time of classes.

To take into account the external variables of the organization during the experiment, the following features were taken to eliminate their influence on the experiment:

- The consent of all schoolchildren, their parents and legal representatives to participate in the experiment was obtained;
- A program of classes was drawn up, their frequency and time did not change;
- Strict control of conditions and fixation was carried out for the entire process of working with timelines;
- It was monitored that in other educational institutions attended by schoolchildren during the experiment there was no systematic work affecting the monitored indicators;
- The same studio managers participated in the experiment;
- Studies were held in the same classrooms. The tool of timeline has not changed.

Possible external variables: material and technical base, motivation and mood of the subjects, parental consent, experience and qualification of the studio manager, duration and time of classes.

The tasks of the speech development studio «In the know» are to master the technique of speech, to develop the natural voice, to get rid of the stiffness in speech and in the body, to learn how to manage emotions and keep the attention of the interlocutor.

Individual classes are focused on choosing a personal program aimed at spot detection and correction of speech errors, psychological and bodily stiffness.

Group classes according to the programs of training courses offered in the studio allow to improve the speech together, in a team, overcome embarrassment and fear of public speaking.

The tasks of the studio for photo and video art «Perspective» are the development of teenagers' creativity; the study of technologies for creating artistic photography, video and animated films from the script, videography to editing and post-processing.

The unique character of the presented additional education studios consists in a comprehensive method of teaching fundamentally different types of activities within the same direction.

The system-forming factor for the developed classes is the timeline implemented in the web service.

The practical application of interactive timelines has also been implemented in the activities of the Pushkin Central City Library (Kirov) during planning and holding the All-Russian action "Bibliomight – 2023".

3.3. Stages of research

At the preparatory stage, the teacher analyzed the potential of innovative digital technologies for the development of schoolchildren's creative thinking in additional education, studied the timeline constructors.

Further testing was carried out under the conditions of the modified and adapted Williams test. The maximum possible total for the entire test is 131. While interpreting the results, points were calculated for each of the indicators.

According to the sum of the points, levels of the development of creative thinking were determined: "High" (the total number of points from 89 to 131), "Medium" (69–88 points) and "Low" (up to 68 points)

The level is "High" when the student offers interesting, non-standard solutions for designing the timeline, compiling text explanations and formulating its name. He/she is active in "sketching" associations and easily changes the interactive timeline based on comments (new requirements and challenges). The participant of information interaction is independent in detecting and visualizing cause-and-effect relationships between events.

The level is "Medium" if the student quite actively offers solutions for designing the timeline, but they are not always non-standard and interesting from the point of view of the design or the content of the timeline. When formulating a name for the resource, he/she refers to additional information sources. He/she is periodically active in "sketching" associations. But changing the timeline based on comments (new requirements and challenges) often causes confusion and a decrease in the pace of work for a teenager. The participant of information interaction is not always independent in detecting cause-and-effect relationships between events, however, easily visualizes them by means of a web application.

The level is "Low" when the student experiences significant difficulties in designing and composing a text for the timeline, labeling and formulating its name. He/she practically does not find associations. He/she sharply negatively perceives the proposal from studio managers to improve the interactive timeline based on comments (new requirements and challenges). The participant of information interaction finds and visualizes cause-and-effect relationships between events only with constant pedagogical support.

Thus, it was possible to collect data on 60 schoolchildren who attended the speech development studio «In the know» and the studio for photo and video art «Perspective».

Based on the testing materials (the essence is described in clause 4.3.1.), control (30 schoolchildren) and experimental (30 schoolchildren) groups were formed.

In order for the survey results to be representative of the study, the size of the population is equal to the number of all pupils of studios.

On the second stage of the study, the implementation of the training program was carried out according to the system of classes described in clause 4.2. The systematization of theoretical and accumulated empirical experience in the aspect of the problem was also carried out.

On the third stage of the study, the main conclusions and recommendations on the use of timelines for the development of schoolchildren's creative thinking in additional education were formulated.

4. Results

4.1. Key concepts and factors influencing the development of schoolchildren's creative thinking in the conditions of additional education when working with online timeline services

Additional education in the presented study is a type of education focused on:

- Forming and developing creative abilities of participants in the didactic process;
- Satisfying their individual needs for intellectual, moral and physical improvement;

- Forming a culture of life safety, including information;
- Organizing free time for children and adults.

Additional education is studied by the authors in technical, natural science, socio-humanitarian, artistic, tourist and local history directions.

The basis for experimental work is the creative studios «In the know» and «Perspective».

The choice of these institutions of additional education is due to the following factors:

- 1) Classes according to the studio managers' training programs are focused on the development of creativity of the younger generation;
- 2) Classes contribute to the artistic, aesthetic, moral education of children on different stages of their socialization, including a difficult period of growing up in middle and high school;
- 3) Classes allow to distract children from negative influences and help them professionally decide in the future. The culture of modern society is becoming more and more spectacular, and skills in the field of photography, computer presentation, video are in demand for people of any specialty.

The main directions of the studios («Perspective»/«In the know»):

- "Fundamentals of Photography"/"Fundamentals of Speech";
- "Videography and editing technique"/"Speech technique";
- "Scenario work"/"Public speaking";
- "Fundamentals of acting"/"Voice and Confidence";
- "Fundamentals of computer animation", "History and development of cinematography (or variants – printing, computers)".

In the presented study, creative thinking is considered from the position formulated by A.Ya. Ponomarev: it involves generating qualitatively new or improving existing solutions to the problem (Ponomarev, 1976). But at the same time, according to the previously mentioned ideas of J. Guilford, "creativity" will be considered through the prism of the maturity of such indicators as fluency, flexibility, productivity and complexity (degree of development) (Guilford, 1956).

The atmosphere of informal communication prevailing in studio classes, the encouragement of personal creative activity affects the formation and manifestation of children's creative initiative, synthetic skills, flexibility of thinking. They develop creative abilities and artistic taste, interest in cinema and photography, imaginative perception of the world around them, the ability to assess their own capabilities and work in a creative group.

The study presented understands the "timeline" as an infographic tool that allows you to create a visual history unfolding in time based on events and facts organized in chronological order, and to present it as a time axis.

Timeline Designer is an online service that allows you to create, edit and distribute a timeline in a digital representation on the Internet.

Thus, the timeline constructors in the educational process are optimal to use in the following cases: familiarizing with the events in chronological order, in order of their significance; performing a comprehensive analysis and forming a holistic view of the phenomenon under study; designing a "timeline" with research results by stages (end/beginning) of project activity; supporting self-organization, self-improvement (at trainings, courses); fixing the deadlines for individual tasks (individual route) and independent work.

An interactive timeline created in the online service is easy to open for editing and creative collaboration. The ability to track changes on a virtual timeline in real mode stimulates imagination, triggers cognitive activity. According to Ya.A. Ponomarev, creative thinking is initiated (Ponomarev, 1976).

Online services for creating interactive timelines expand the space of creative activity, provide new opportunities for activating creative potential.

It was determined that the timeline should be distinguished from other types of information visualization, in particular, based on the following features: a bulk of text component; mandatory fixation of time intervals; the possibility of a fully functional existence only on the Internet.

Digital content is defined as information material that can become a conductor of the main idea, act to convey a message or the main idea.

The integration of educational areas when working with timelines fits seamlessly into the project method, which, according to the requirements of additional education, is the leading method in working with children. It is the "timeline" that can support students in understanding the retrospective of the surrounding world.

Indeed, the formation of ideas about time and historical development cause special difficulties for schoolchildren. It is quite difficult to imagine without using visual aids such concepts as "film development algorithm", "heteroclines", "structure and principles of operation of a video camera", "data search", "network etiquette". The timeline as a time scale allowed schoolchildren to perceive these abstract concepts and apply them in practice.

Next, we will present a system of classes for working with an interactive timeline, which does not have a rigid structure. The system of classes can adapt to the challenges of society and the needs of the participants of information interaction in the conditions of additional education.

4.2. The program of classes on working with interactive timelines

The system-forming factor in the system of developed classes is a timeline implemented in the web service.

Lesson I is the analysis of ready-made timelines presented in print and electronic forms, with identifying potential opportunities for their use in the studio work: biographies of prominent figures, the history of discoveries, algorithms of actions, discussion of the advantages/disadvantages of timelines in a digital format.

Lesson II is the analysis of Internet resources to create interactive timelines. The participants of the information interaction analyzed digital services for timelines: Story Map JS, Tiki-Toki, Sutori, Timeglider, Preceden, MyHistro, SmartDraw, Timeline JS. It was decided to use the latter in the studios of additional education.

Lessons III and IV are devoted to creating interactive timelines.

The work was organized according to the algorithm:

1. Carrying out preparatory work with information. Events were collected in a text files, which were then added to the timeline. The following information was determined for each event: the date, a link to a photo, video or code, for example, on a map or infographic.

2. Switching to the Timeline JS web service (<https://timeline.knightlab.com/>). You do not need to register on the service. To get started, you click on the green button in the center of the screen "Make a Timeline", then on the blue button "Get the Spreadsheet Template".

3. Creating a new Google table using the service template. It was copied to the Google Drive account when clicking on the "Make a copy" button.

4. Filling in the table. Preview and modification.

The use of the timeline in additional education was carried out in the following cases: to display historical facts in chronological order; to prepare a chronicle of current events; to create a biography; to illustrate statistics.

Working with online services for creating timelines affected the main indicators of the maturity of creative thinking in the following way:

1) originality, i.e. the ability to see non-standard solutions, develops when drawing up a plan (reference points, milestones, division scales) on the timeline;

2) fluency – the variety of associations that students have when visualizing history, for example, when designing a timeline on the history of the development of artificial intelligence (web, human brain, fantastic character);

3) flexibility manifests itself when the teacher formulated and gradually supplemented the system of requirements for the timeline, for example: place at least 10 events on the line; provide for two or more events starting at the same time, etc.;

4) degree of development appears when students found and visualized cause-and-effect relationships between phenomena. For example, "Johann Gutenberg is the Creator of printing. "Latin grammar" and indulgences. Life before the printing press. The first experiments. Financial difficulties. Gutenberg studies. On the way to discovery. Career of a jeweler Who invented printing? Time travel. American inventions. Memory".

5) naming, i.e. the students skillfully and wittily used language tools and the vocabulary in the design of the text on the timeline. The timeline text is a meaningful element of infographics that combines multimedia components.

Lesson V is the analysis, discussion of the designed interactive timeline and the result obtained (a developed film). If there were significant disagreements, the timeline was re-checked and finalized.

Lesson VI is a foresight session, when options for using the developed interactive timeline were proposed, for example, for students of the Vyatka State University, or to support the Pushkin

Central City Library while planning and holding the All-Russian action "Bibliomart – 2023". The developed timelines were used in the framework of exhibitions and virtual excursions "From Voronezh to Paris" and "Bunin in the Oryol region".

The participants further applied the received timelines at other studio events (art meetings, brainstorming sessions, auctions of knowledge, etc.).

4.3. Experimental assessment

4.3.1. The ascertaining stage of the experiment

60 schoolchildren (50 % – boys, 50 % – girls) were involved in the experimental work in conditions of additional education.

To assess the input conditions (the level of the creative thinking development), students were offered 12 pictures. The instruction for schoolchildren said: "It is necessary to draw quickly an unusual picture that no one else can come up with. You will be given 20 (25) minutes. When creating an image, use a line or a figure inside each square. Make it a part of the picture. You can draw anywhere inside the square, depending on what you want to depict. You can use different colors. After completing the work, come up with its name and fix it. The name should tell about what is depicted in the picture, reveal its meaning".

The result is five indicators expressed in points:

- Fluency – the maximum possible score is 12;
- Flexibility – maximum possible score – 11;
- Originality – the maximum possible score is 36;
- Degree of development – the maximum possible score is 36;
- Naming – the maximum possible score is 36.

Thus, taking into account the results of the materials processed, it was possible to collect data on 60 schoolchildren. Experimental and control groups were formed. 30 people were selected for the experimental group: 15 girls and 15 boys. The average age of respondents is 15 years.

The norms of research ethics are also taken into account when conducting the experiment (especially considering that the experiment is conducted with the participation of minors). Studio managers informed both schoolchildren and their parents about the stages of work. They answered all the questions that arise, solved organizational difficulties. All rules of information security and sanitary-hygienic requirements were observed.

4.3.2. Forming stage of the experiment

The tasks of the speech development studio «In the know» are to master the technique of speech, to identify the natural voice, to get rid of the stiffness in speech and in the body, to learn how to manage emotions and keep the attention of the interlocutor.

The tasks of the studio for photo and video art «Perspective» are developing teenagers' creativity; studying technologies for creating artistic photography, video and animated films from the script, videography to editing and post-processing.

The unique character of the presented additional education studios consists in a comprehensive method of teaching fundamentally different types of activities within the same direction.

Classes in the speech development studio «In the know» were held twice a week (Tuesday-Thursday), also twice a week in the studio for photo and video art «Perspective», but on Wednesdays and Fridays. Studio managers did not change during the study period.

The participants of the experimental group started working with services for creating interactive timelines (using the Timeline JS service) according to the program presented in clause 4.2.

We will describe the algorithm of developing the film formulated in the process of information interaction: preparation of solutions (fixer and developer); placing the film in the tank for development; setting the time for development on the timer; pouring the solution with the developer into the tank with the film; rotation of the spiral located inside the tank; draining the solution once the time expires and filling the tank with water; scrolling the spiral and draining the liquid; pouring a fixative into the tank; flushing the tank with the film; cleaning the film from drops using suede and forceps; hanging the film and fixing it.

Text messages for the stages were registered in the studio «In the know», and photo/video accompaniment was provided by the participants of the studio «Perspective». Then the algorithm was implemented in accordance with the timing.

Other examples of timelines developed by the participants that were included in the further educational process: the chronology of the invention of radio; the history of printing (the evolution of ideas and technology); the sequence of actions of the rhetorician in preparing an argumentative speech; rules of network etiquette, etc.

The participants of the control group also studied in the studios of the speech development and photo and video art and used computer-free timelines. The production of the "line" necessarily represented an artistic and aesthetic process. Students photographed or drew, cut, pasted and signed images of objects. Music was often used in classes with the "line": dances of the peoples of the world, round dances, singing songs, etc.

However, they were not involved in the study of online services for creating time lines.

Examples of tasks fulfilled by the participants with the help of information resources: compilation of cards with the rules of network etiquette, the analysis of vector and raster data, the image of road signs and logos.

4.3. 3. Control stage of the experiment

Information about the results of evaluating "before" and "after" experimental research work and the use of online services to create timelines for the development of schoolchildren's creative thinking additional education is provided in [Table 1](#).

Table 1. Results of the work on creating timelines for the development of schoolchildren's creative thinking additional education

Level	Groups			
	Experimental group (30 pupils)		Control group (30 pupils)	
	Before the experiment	After the experiment	Before the experiment	After the experiment
«High»	5 (16.7 %)	12 (40.0 %)	5 (16.7 %)	6 (20.0 %)
«Average»	11 (36.6 %)	14 (46.7 %)	12 (40.0 %)	12 (40.0 %)
«Low»	14 (46.7 %)	4 (13.3 %)	13 (43.3 %)	12 (40.0 %)

The following hypotheses were accepted: H₀: the level of schoolchildren's creative thinking in the experimental group is statistically equal to the level in the control group; H₁: the level in the experimental group is higher than the level in the control group. For $\alpha = 0.05$, χ^2 is 5.991. We got: $\chi^2_{\text{observed.1}} < \chi^2_{\text{critical}}$ ($0.081 < 5.991$), and $\chi^2_{\text{observed.2}} > \chi^2_{\text{critical}}$ ($6.154 > 5.991$). Consequently, the increase in the level of the development of schoolchildren's creative thinking f in additional education in the experimental group can be considered non-accidental.

Performing a qualitative assessment of the results obtained, we note that the number of students in the experimental group with the level of the development of creative thinking "High" increased from 16.7 % to 40 %. In the control group, this indicator increased from 16.7 % to 20 %. In the experimental group positive dynamics was recorded at the "Average" levels: the increase was 10.1 %. In the control group, this indicator remained unchanged. In both groups, the number of students with the "Low" level decreased: in the experimental group from 46.7 % to 13/3 %, and in the control group – from 43.3 % to 40 %.

Thus, the obtained qualitative and quantitative changes in the results allow us to make an objective conclusion about the significant didactic potential of using timeline services for the development of schoolchildren's creative thinking additional education.

5. Limitations

Let's pay attention to possible limitations for the study:

1. Choosing the form of additional education – a studio. Unlike clubs, the purpose of classes in the studio is not to prepare children to participate in competitions and achieve high results. Although, the participants sometimes take part in small local competitions. The main purpose of the classes is creative development, leisure activities and the formation of basic knowledge and skills in accordance with the challenges of the XXI century. In studios children do not just play, they necessarily get theoretical knowledge and master certain skills.

2. An important condition is that throughout the experiment the same studio managers were engaged with schoolchildren. Classes were held according to the same schedule (days of the week,

duration, rest period after lessons in a general education institution). Sanitary and hygienic standards were taken into account for the organization of the activities of studios using ICT tools (computer, electronic gadgets, etc.).

6. Discussion

The development of schoolchildren's creative thinking in the conditions of modern digital educational environment is an urgent problem of research for Russian and foreign scientists. The research materials correspond to the principles and goals of sustainable development formulated by the UN, in particular Goal 4 ([17 Goals..., 2023](#)). When developing the training program, it was taken into account that working with interactive timelines in additional education will contribute to:

- 1) Acquiring knowledge and skills to promote sustainable development;
- 2) Creating didactic resources that would be informative, safe and taking into account all the needs, including children with disabilities.

During the discussion, there were identified the activities with timelines that most affect the development of creative thinking:

1. Of particular value is the activity with online services, when schoolchildren's ability to portray events and phenomena of the future is formed. Events where they need to convey not only the appearance of the idea, but also add new functions to it.

2. In the course of discussing and constructing the timeline, its creators had a variety of associations, which contributed to the development of fluency of thinking.

3. The scale of the Internet allowed students to work with a large array of information, to find unique materials. All these factors contribute to the development of such characteristics as originality of thinking.

4. The opportunity to use Internet services when editing, modifying the timeline allows you to support foresight technologies for designing the goals of the future in education, self-study and self-improvement. At the same time, flexibility of thinking develops.

5. At the same time, the virtual format allows you to create an objective retrospective of historical events (discoveries, biographies), revealing cause-and-effect relationships between them. In other words, the degree of development of thinking is manifested.

6. And, of course, all the work with timelines took place in an information communication environment, which contributes to the development of language tools and vocabulary.

The conclusions obtained confirm the results of the work of J.B. Carroll, J. Goodwin, M.K. Oliver about the importance of additional education for increasing creative activity and successful socialization ([Carroll et al., 2007](#)).

In addition, the didactic potential of digital services for the development of students' creative thinking was confirmed, presented in the work of N.Ya. Ageev, Y.A. Tokarchuk, A.M. Tokarchuk, E.V. Gavrilova ([Ageev et al., 2023](#)).

A significant result of the study is the description of the basic ideas of the approach that expand the ideas of S.Yu. Stepanov, I.V. Ryabova, E.V. Gavrilova about the influence of the digital environment and additional education on the schoolchildren's intellectual and creative abilities ([Stepanov et al., 2021](#)).

It is proved that working with an interactive timeline really creates additional conditions for the development of schoolchildren's imagery, originality and speed of perception. It is the computer "timeline" that helps to understand that a person can creatively approach the transformation of the real world around him, purposefully "adjust" objects (and phenomena) to both his own and social needs.

7. Conclusion

The results of the study made it possible to identify the following didactic possibilities of using online services to create timelines for the development of schoolchildren's creative thinking in additional education:

- Multiple use – an interactive timeline can be incorporated in a blog, website and repeatedly accessed; a digital archive can be created. In the future, if necessary, it is possible to return to the information resource and creatively process it;

- Social orientation – the interactive timeline can be viewed by a large number of users, commented and evaluated, distributed and applied in network communication;

- Multimedia presentation – not only text messages, but also graphics and videos are placed on the interactive timeline;
- Artistic and aesthetic education – the development of accuracy, aesthetics of perception. This is manifested and supported through the desire to design an interactive timeline in a single style; to create an up-to-date design. The student has an opportunity to show creativity, individuality in the design of both the visual series and in the text content;
- Technical minimalism – timeline services do not impose special requirements on the software. Interactive timelines are supported by most browsers;
- A combination of different types of educational materials (reference books, dictionaries, atlases). There are opportunities to systematize the information presented in different types (including various classifications);
- Cognitive analysis – interactive timelines allow you to visually and dynamically establish cause-and-effect relationships.

As difficulties that complicate the use of timeline in additional education, we note: the need for a systematic study of the experience of evaluating the effectiveness of using services for working with timelines; the development of criteria and indicators for the effective use of web services for appropriate purposes in an institution of additional education for children (managerial, educational, educational, personnel and aspects).

The results obtained can be used:

- In the activities of developing courses aimed at in-depth study of the school curriculum and expanding the schoolchildren's horizons;
- In students' project and research activities;
- In the work of experimental sites. When organizing classes not only on the territory of the university, but also in schools and organizations of primary and secondary vocational education;
- In social projects (center for helping children with disabilities; social cluster for raising awareness of families);
- In various additional education programs to support and promote the ideas of the federal project "Success of every child" of the national project "Education".

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