Visual Programming Environment Scratch in The Study of the School Subject "Fundamentals of Life Safety"

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ABSTRACT

The aim of the work was to study the effectiveness of the implementing technology of Scratch lessons in the study of the school subject "Fundamentals of life safety" in secondary school. The authors used a natural comparative pedagogical experiment. Pedagogical experiment included three stages: ascertaining stage – initial (before experiment) control of knowledge, abilities and skills of the trainees; forming stage – application of new training forms, methods or technologies; and controlling stage – evaluation of the effectiveness of new training forms, methods or technologies based on the final (after the experiment) control of acquired knowledge and skills. The experiment was conducted in 2018-2019 academic years (from September to April) according to the programs of the 5th to 9th grades of secondary school based on the municipal autonomous educational institution "Secondary school No. 12" of Syktyvkar, Komi Republic. The experiment involved 431 pupils from 15 grades. Among them, 217 pupils were included in an experimental group, in which the study of the life safety basics was carried out using Scratch environment, while 214 pupils were included in the control group, where the study of the same subject was carried out without the use of Scratch environment. To assess the effectiveness of the implementation of Scratch lessons, the authors have identified the following indicators: the number of terms and concepts learned; the correctness of actions and their order in various household and emergency situations; and correct assessment of the consequences of decisions taken in various domestic and emergency situations. The pedagogical experiment revealed greater involvement in the educational process, as well as greater interest in the taught material among pupils of the experimental group, who manifested the presence of basic programming skills, higher level of logical thinking compared to the control group. In the experimental group, a tendency in increasing teamwork among pupils on their own initiative was noted. This research can be applied in pedagogical studies on the influence of simple programming environments on personal, metasubject and subject-based results of training. The Scratch program in a secondary school in different countries of the world is most often used in the study of computer science, mathematics, physics, and foreign languages, and more rarely in the study of literature, geography, ecology, history, and music. The originality of the study consists in the use of Scratch program when studying the life safety basics.

1. INTRODUCTION

Scratch is free visual programming environment developed in 2006 under the supervision of M. Resnick by a Lifelong Kindergarten group at the Media Lab of Massachusetts Institute of Technology (MIT). Scratch can be used in Windows or Linux environments and can operate without Internet connection [1, 2]. The program allows children from seven years old to create their own stories, cartoons, games, and other works, and thus express themselves in computer creativity. Scratch allows creating animation, developing various games, modifying their appearance, moving them around the screen, and setting the forms of interaction between them. The program uses block-based programming, i.e. objects in the program are created from multicolored blocks, similar to bricks from LEGO [3-6].

The attractiveness and simplicity of the program make it possible to successfully apply Scratch worldwide [7] when teaching school subjects and to establish interdisciplinary connections among them. An important condition, when using Scratch in the study of school subjects, is that this environment requires minimum skills in pupils. Since 2015, in some educational organizations in Russia, the study of the elective course of "Propaedeutics of programming with Scratch" is successfully implemented. In the frameworks of this subject, pupils are getting acquainted with the software environment, computer graphics environment, algorithms and performers, project activities, and modeling of processes in the system. The use of the Scratch programming environment significantly affects the personal results of trainees, since it forms in children the following attitudes and skills:

- responsible attitude to learning and the ability to bring started to the end;
- the ability to self-development and self-education by means of information technology;
- develops basic programming skills;
- forms a holistic worldview corresponding to the current level of information technology development;
- gives the opportunity to conduct project training and thus contributes to the level of self-esteem through the implemented projects;

- develops communication skills of trainees through cooperation with peers in the framework of team projects;
- teaches to respect the opinion of another person and his contributions in the framework of joint project activities;
- helps to learn the rules of safe behavior when working with a computer;

Scratch contributes to metasubject learning outcomes, such as the ability to independently set and formulate new tasks for themselves, the ability to develop the motives of their cognitive activity; the ability to independently plan ways to solve the problem in order to obtain an effective result; the ability to critically assess the correctness of the solution of the educational and research problem; the ability to adjust their actions, make changes to the program and debug it in accordance with changing conditions; possession of the basics of self-control, decision-making; ability to create, apply and transform signs and symbols, models and schemes for the solution of educational research and design works; formation and development of competence in the application of information and communication technologies; ability to organize educational cooperation and joint activity with the teacher and peers in the course of project and educational research activity.

Scratch allows generating subject results of learning, namely, realizing the importance of mathematics and computer science in everyday life of modern human; forming ideas about the basic subject concepts, such as information, algorithm, programming, and their characteristics; developing logical abilities and algorithmic thinking; extending ideas about numbers, numerical systems; mastering the symbolic language of algebra, acquiring the ability to make and use complex algebraic expressions for modeling educational projects, simulating real situations in the language of algebra; developing spatial representations as well as skills of geometrical constructions and modeling of such processes, developing visual skills by means of information and communication technologies; as well as forming ability to observe norms of information ethics and law.

The Scratch program in high school of different countries of the world is most often used in the study of school subjects such as computer science, mathematics [8-10], physics and foreign languages. Less often it is used in the study of literature, geography, ecology [10], and history. This program is not used in the study of music, biology, and the basics of life safety.

2. PROPOSED METHODOLOGY

To clarify and confirm the hypothesis that the implementation of Scratch lessons in the study of the fundamentals of life safety will allow pupils to more efficiently and fully absorb the knowledge and skills on the subject through interdisciplinary connections, a natural comparative pedagogical experiment was applied. The pedagogical experiment included three stages:

1. Ascertaining stage consisted in the initial (before the experiment) control of knowledge and skills of trainees;

2. The formative stage consisted in the application of new training forms, methods or technologies;

3. The controlling stage consisted in an evaluation of the effectiveness of new training forms, methods or technologies based on the final (after the experiment) control of knowledge and skills.

The pedagogical experiment on the implementation of Scratch lessons in the study of the fundamentals of life safety was conducted in the 2018-2019 academic year (from September to April) according to the programs from the 5th to 9th grades of secondary school based on the municipal autonomous educational institution "Secondary school No. 12" of Syktyvkar, Komi Republic. The age of pupils was, firstly, selected due to the presence of their skills in the Scratch environment, and secondly, due to the fact that the Scratch programming environment was more attractive for middle-grade school children. The experiment involved more than 400 pupils from 15 grades. Among them, 217 pupils were included in the experimental group, in which the study of the life safety basics was carried out using Scratch environment, while 214 pupils were included in the control group, where the study of the same subject was carried out without the use of Scratch environment.

Integration of the subject "Fundamentals of life safety" and Scratch was carried out through the creation in the program of animations, games, stories, visualized scenarios, interactive tests and quizzes, and interactive competitions on the topics presented in Table 1.At the end of the testing period, the results of the technology application were evaluated.

Table 1. Sections and topics of the subject "Fundamentals of life safety", the most convenient for their integration with Scratch

Section name	Topic name
Section 1. Ensuring personal safety in everyday life	Topic 1. Fundamentals of healthy lifestyle, medical knowledge, and first aid to victims
	Topic 2. Streets and road safety
	Topic 3. Safety in the domestic environment
	Topic 4. Safety in the natural environment
	Topic 5. Safety on water bodies
	Topic 6. Safety in the social environment
Section 2. Ensuring personal safety in emergency situations	Topic 1. Fire safety and rules of conduct in case of fire
	Topic 2. Safety in natural emergency situations
	Topic 3. Safety in man-made emergencies
	Topic 4. Use of personal and collective protection equipment
	Topic 5. The actions of the population at the alarm "Attention all!" and during the evacuation

It is important to note that Scratch lessons were used in the experimental group as an addition to the basic methods of training due to the fact that for pupils, programming in this environment took enough time.

The development and writing of the script of the future story, plot, cartoon, or game, pupils of the experimental group carried out independently that increased the cognitive interest of children and forced them to turn to additional sources of information when studying the subject – all this contributed to deep conscious study of the educational material. In the study of the most topics, command-project-based learning was used. With this approach, each individual team member was responsible for developing specific issues of the future project (writing a script, developing details of future visual images (colors, location, etc.), drawing individual scenes, etc.) that contributed to the cohesion of the team, especially in grades with poor communication.

To assess the effectiveness of testing the implementation technology of Scratch lessons in the study of the school subject "Fundamentals of life safety", the authors have identified the following indicators:

- the number of terms and concepts learned (indicator 1);

- the correctness of actions and their order in various household and emergency situations (indicator 2);

- correct assessment of the consequences of decisions taken in various domestic and emergency situations (indicator 3).

3. RESULT AND DISCUSSION

The results of the primary assessment (before the experiment) of knowledge and skills of pupils of the experimental and control groups when studying on life safety were almost similar and had no significant differences.

Results of indicator 1: analysis of the number of terms and concepts learned during the entire period of the experiment was carried out through the solution by pupils of open and closed tests. Out of 100 concepts on various topics, 92 terms were learned on average in the experimental group, and only 66 in the control group (see Table 2, Fig. 1).

Table 2. The number of terms and concepts learned in experimental and control groups

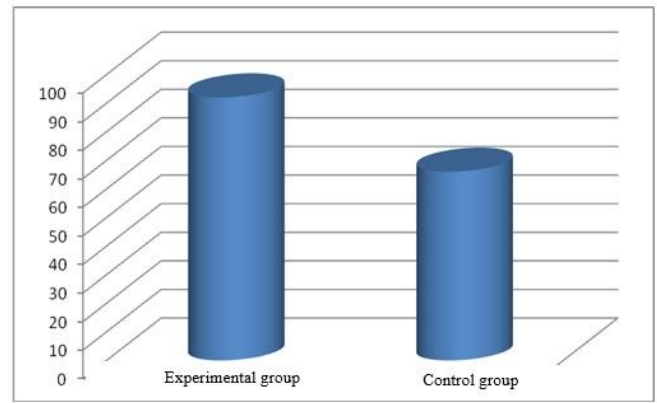|	Experimental group	Control group
The number of terms and concepts learned	92	66

Figure 1: Analysis of the indicator "Number of terms and concepts learned" in the experimental and control groups.

Results of indicator 2: analysis of the correctness of actions and the order of their implementation in various domestic and emergency situations was carried out by solving by pupils of simple 32 situational tasks. Both the experimental and control groups solved the same situational problems after studying the training material at the end of the experiment. Out of the 32 tasks, 29 tasks were correctly solved by the pupils of the experimental group, while only 23 by the pupils of the control group (see Table 3, Fig. 2).

Table 3: The number of correctly solved situational problems in the experimental and control groups

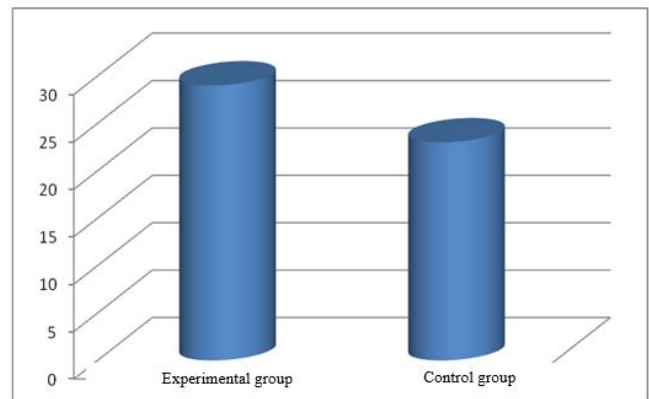|	Experimental group	Control group
The number of correctly solved situational problems	29	23

Figure 2: Analysis of the indicator "Correctness of actions and their order in various household and emergency situations" in the experimental and control groups

Results of indicator 3: the analysis of the correct assessment of the impact of decisions taken by others in various domestic and emergency situations was carried out through the analysis of actions taken by other children and adolescents in different life situations. In total, pupils had to analyze 45 situations of different nature (Table 4, Fig. 3).

Table 4: The number of correctly assessed the consequences of the decisions taken by others in a variety of everyday and emergency situations

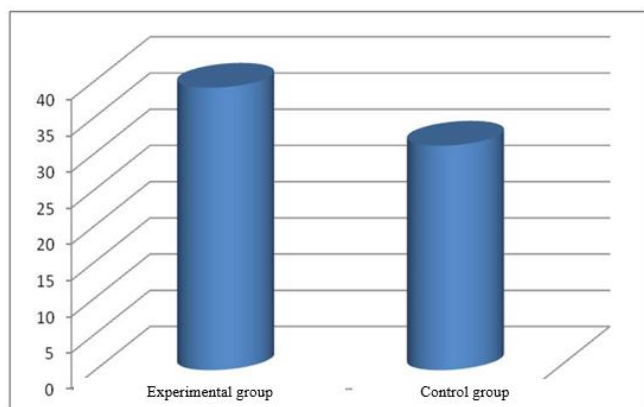|	Experimental group	Control group
The number of correctly assessed consequences of the decisions taken by others in a variety of everyday and emergency situations	39	31

Figure 3: Analysis of the indicator "Correct assessment of the consequences of decisions taken in various domestic and emergency situations", in the experimental and control groups

The generalized analysis of all three indicators revealed deeper knowledge and skills of pupils in the experimental group. The trainees of this group quickly coped with tests and situational tasks and were not undecided when answering them. As in other studies [11], the implementation of Scratch in this case revealed in the experimental group of pupils greater involvement in the educational process, greater interest in the studied material, the presence of basic programming skills, and higher level of logical thinking compared to the pupils of the control group. In the grades of the experimental group, a tendency to increase the share of teamwork among pupils on their own initiative was noted as compared to the pupils of the control group. The experiment has shown that the use of simple visual programming environment such as Scratch, when studying school subjects, has a positive effect on personal, metasubject, and subject learning outcomes.

5. CONCLUSION

Thus, the approbation of the implementation of Scratch lessons technology in the study of the school subject "Fundamentals of life safety" according to the programs of grades 5-9 of the secondary school has shown its effectiveness. When implementing this technology, it is necessary to take into account the time spent by pupils when working in this environment. Therefore, no more than 4-5 integrated lessons should be conducted on this technology during training trimester. The most successful solution will be organizing this type of activity beyond basic education in the form of a circle activity or a hobby club.

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