

Systematic information security training in elementary school

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Abstract — Issue and purpose. The article reveals the urgent problem of the systematic training of information security (IS) in primary school. The purpose of the article is to present an approach to the formation of the content of information security education for primary school children, taking into account possible sources and situations of information threats. **Methodology.** The methodological base of the study is the activity approach, the theory of situational and contextual learning. The solution of the study issues was provided by a set of methods based on the analysis of domestic and foreign pedagogical theory and practice in the field of ensuring information security of an individual; general scientific methods, including modeling, matching, comparison and generalization; experimental methods using diagnostic tools, expert estimates and statistical processing of the results of a pedagogical experiment. **Results.** The article explores the issues of teaching information security to primary school students. In the course of the study, an analysis was made of the characteristics of the perception of information critical for the life of a younger student, the social groups of its possible information communication were identified, the sources of information threats typical for young students were identified, a model for the formation of the content of information security training for younger students was developed, which forms the basis for the formation of the methodology basics of information security training at the primary school stage. **Conclusions.** The results obtained indicate the need to implement the developed model for teaching information security to junior schoolchildren in the educational environment of the school with the involvement of parents, family, the system of vocational education, public organizations and social services.

Keywords — informatization of education, sources of information threats, information security of schoolchildren, situations of information threats, situational training, digital education.

I. INTRODUCTION

The main task of a modern school is to reveal the student's abilities, to form his readiness for life in a competitive and high-tech society. Education at school is designed to promote personal growth, the formation of independence in setting and

achieving serious goals, the ability to respond in a timely manner to various situations that arise in the student's life.

A schoolchild, being involved in the cognitive process, in many respects appears to be unprotected from the influence of various flows of information coming from different sources. The constant propaganda of violence and cruelty by the media, the widespread use of the Internet, uncontrolled communities on social networks that promote deviant behavior are a socio-pedagogical problem, first of all, depending on the quality of the information culture of the personality being formed, its degree of maturity and readiness for full self-realization in society. In addition, there are acute issues of protecting confidential information and personal data, propaedeutics of skills in this area as applied to the digital economy society, which is reflected in the study of H. Chou, C. Chen [1].

A productive way to ensure the child's information security is to teach him to adequately perceive and evaluate information, taking the situation into account, from the point of critical understanding of it on the basis of cultural and moral values formed in the educational process, which will minimize the consequences of negative moral, mental and physiological effects on the schoolchild. The phenomenological approach to the study of critical thinking based on the understanding of the schoolchild and the design of the educational process for the development of critical thinking of students are considered in K. Larsson [2]. P. Rooney notes the importance of cultural values in the safe development of the school educational environment, subject to dynamic changes during times of change [3].

N.N. Vlasyuk, B.O. Mayer note [4] that an important component of the concept of "education for sustainable development" is an understanding of belonging to a global and interconnected world, responsibility for one's own actions, and teaching safe behavior for others and themselves. Training on information security in the digital economy information society is becoming a significant part of the "education for sustainable development" system.

An essential role in the formation of competencies in the field of ensuring personal information security is played by the primary school due to the sensitivity of the age of students, considerable confidence in the teacher, and their desire to learn new things. In this regard, there is a need to expand the existing content of primary education through systematic training in the basics of information security in primary school. This stage of training should create the conditions for ensuring the continuity of the formation of knowledge on information security at the next stage of school education. In order to achieve continuity between the stages of information security training, goals and objectives, priority areas, conditions, content of information security training, and criteria for assessing knowledge of information security at each stage should be defined.

II. RESEARCH METHODOLOGY

Describing the readiness of children to study at school and the ways of perceiving knowledge that they have for this period, D.B. Elkonin notes: "Preschool childhood is the period of the emergence and flourishing of game, especially (between the ages of 5 and 7 years) role-playing game. It is in a role-playing game, due to the conditionality of actions and the sign nature of the objects involved in them, the main content of the child's activity becomes a kind of modeling of social relations between people, orientation in them... Towards the end of preschool age, various games with rules develop on the basis of role-playing games; their development is important for preparing for schooling, which is imbued with a variety of rules" [5].

T. Fallon, R. Aylett, H. Minnis, G. Rajendran argue [6] that the use of the role-playing method in training the basics of information security gives a better idea of the threats that may arise in relation to them.

The distinctive features of the formation of knowledge in the field of ensuring personal information security of a schoolchild are the following skills: to identify a potential information threat; assess the degree of danger of the consequences of its possible implementation; resist these consequences. Hence the task of a pedagogical study of the development of the student's personality in the information environment of modern society and the development of theoretical and methodological foundations for the formation of the student's ability to counteract information threats that are likely for their environment. Due to the prevailing ways of perceiving knowledge in a junior schoolchild, situated learning of the basics of information security in primary school can be an effective means of solving this problem.

In pedagogical theory, the concept of "situated learning" in the context of the topic under consideration can correspond to the "method of educating situations", which consists in a certain organization of students' activities aimed at solving a specially selected and problem task related to a moral choice, determining a social role, and organization of activities and other aspects.

The teacher models the conditions for the emergence of a problem situation, discusses with their subjects the results of its resolution. When there is the possibility of choice with the

simultaneous presence of conditions for independent resolution by the child in the problem situation, it becomes possible to implement a social test as a means of self-knowledge and determine your capabilities in a particular social role. Social tests are present in almost all spheres of human life, they acquire special significance in matters of ensuring security and as its essential element of personal information security. The experience of children participating in situations that implement social tests forms a definite attitude towards social phenomena in which they develop a sense of social responsibility. The boundaries of individual personality differences and the environmental impact regarding information security aspects are discussed in the work of M. Gratian, S. Bandi, M. Cukier, J. Dykstra, A. Ginther [7].

The theory of context-based education has been successfully applied in the pedagogy of vocational education. Context refers to a system consisting of external and internal factors, as well as the conditions of a person's activity and behavior in it, which together affect the features of perception, understanding, transformation of the surrounding reality and specific situations arising in it, which determine the meaning and significance of each situation as in global and local value [8]. The basic structural component of the content of context-based education is a problem situation that does not exclude the use of traditional static tasks [9].

Many researchers considered various threats to the safety of the schoolchild, containing a significant information component. Let us characterize the range of information threats typical for the junior schoolchild.

The work of S. Yhomee, A. Haren, M. Hagberg is devoted to studies of the time spent on computer equipment and the corresponding effect on sleep disturbance, psychological state of a person, decreased attention, the occurrence of symptoms of stress and depression [10]. The same researchers consider similar symptoms that occur during a long time spent on mobile phones [11]. The work of N. Thompson, T. McGill, X. Wang [12] is devoted to the features of the personal perception of the level of security of working with various personal means of information and communication interaction, in particular, with mobile devices and personal computers. - - -

III. RESULTS OF THE RESEARCH

To develop a model of behavior for a junior schoolchild adequate to the potential threats of the context in which he may find himself, we consider the territorial areas characterizing the likely place in which the child may be: at school, an institution of vocational education, at home, outside the house and childcare (on the street, in public place, visiting, etc.).

To make an informed decision and minimize potential risks from information threats, situated education of information security of schoolchildren at the level of primary education will help.

We understand situated education in information security as the process of forming a model of behavior for a child of primary school age, which helps minimize the consequences

of potential information threats that are characteristic of a given level of education in primary school due to context-based learning in the rules of action in typical situations of information threats.

The formation of information-safe behavior skills in primary school must begin with an analysis of various places and situations in which a child may be in the process of his life. By such situations, in a general sense, we understand the real segments of social life with such attributes as subjects, social context, place, time, content of subjects' activities. Situations involving a threat to human life can be divided into critical, emergency, extreme, dangerous, difficult, complex. The situation is characterized by conditions, factors, its subjects. Situations related to the issues of ensuring information security include the prevention and overcoming of factors containing one or more information threats and the creation of conditions for a safe life. Types of case studies may be different, but, as a rule, the information aspect is an essential part. We list the types of situations characteristic of modeling in the educational process: information, gaming, dosed, really dangerous.

By the place where the child is most of all, situations of possible occurrence of information threats can be divided into four groups: "home alone", "in a comprehensive school", "in institutions of vocational education", "outside the home and childcare."

An analysis of information security threats is the most important aspect of ensuring it. Based on the basic theory and depending on the field of ensuring information security, we single out the criteria that are the basis for the classification of information security threats for a child of primary school age:

- moral and/or psychological impact;
- cheating for the purpose of physical impact and/or profit;
- confidential information leakage.

The basis of training information security for junior schoolchildren is the basic knowledge and skills in working with information, the skills of constructing logical conclusions, the formation of which requires:

1. to develop the ability of critical thinking in the child;
2. to teach the child to independently find additional reliable sources of information in critical situations;
3. to teach the child to determine the type of incoming information;
4. to develop skills to identify factors signaling the occurrence of information threats, to generate knowledge about the possible consequences of their negative impact;
5. to teach the child how to make a decision in an information-dangerous situation.

Organization and results of an experimental study

Three independent groups of schoolchildren from Moscow, St. Petersburg and Novokuznetsk took part in an experiment to evaluate a child's training in behavior at the stages of his presence in an information threat situation and assess his anxiety level during such training. Two classes were

taken in each of the three regions, one of which was a control, and an experiment on situated education of information security was conducted in the other. At the stage of summarizing the results for three regions, two groups of schoolchildren were formed, each of which consisted of three corresponding classes — control and experimental. Thus, two groups of schoolchildren were obtained control, consisting of 74 students of the fourth grade and experimental — from 69 students of the 4th grade.

Systematic training of information security was not conducted in the control group. For this group, within the framework of classroom hours before and after the experiment, a game situation of an IS threat was created and the correctness of the actions of schoolchildren in this situation was assessed.

The content of IS training consisted of two sections: preparatory and situated. The preparatory section is focused on the formation of the child's ideas about the essence of information security and the basic (typical) actions to support personal information security and their inner circle. In the context of the situational section, situations of the IS threat were considered, taking into account who the child is with in an information threat situation (or someone is present within sight): one; with another student; with a teacher or other school personnel; with familiar adults; with unfamiliar adults; with parents or loved ones; with a policeman, doctor, firefighter and other people in the form appropriate to their work.

We have identified the sequence of actions of the child in a situation of information threat and its resolution:

- determining the presence of the IS threat by its signs, determining the threat by the signs of the IS threat can be carried out according to the actions of a possible attacker: reports unusual information, disseminates (offensive or false) information, asks to do something forbidden, etc.
- recognition of the IS threat with the determination of the source of information (primary or secondary) and the threat class, depending on the source of information, the threat class is determined: low threat level (parents, close person), medium threat level (friend, classmate, teacher, school administration), high threat level (unfamiliar, strange person).
- analysis of ways to resolve the IS threat situation, includes determining in relation to whom the information threat is directed and deciding on the urgency and necessary actions.

To assess the child's training in behavior in the context of the information security threat in the experimental and control classes, information threat situations were simulated before and after the experiment. At the end of the game situation, the student was asked questions to identify the signs of the IS threat, recognize the IS threat, determine the source of information and the class of threat, analyze the situation, the correct behavior of the participants in the situation in question and their actions to resolve the threat situation.

To ensure confidentiality in making decisions, students were given envelopes with questions requiring an unambiguous answer and pieces of paper in green and red. The schoolchild, in the positive answer to the question written on the card from the next envelope, put a green strip in the envelope along with the question card, with a negative answer a red strip.

Thus, for the independent control and experimental groups, the degree of change in the correctness of the actions of the fourth-grade student at each of the four stages considered above of the child's presence in an information threat situation was evaluated. The following results were obtained, presented in Table 1.

TABLE I. Experimental data on the training of the correctness of the actions of fourth-grade schoolchildren in situations of information threats

	Number of correct answers							
	Before the experiment				After the experiment			
	Experimental group		Control group		Experimental group		Control group	
Total testees in each group	74		69		74		69	
	Number of people	Percentage in %	Number of people	Percentage in %	Number of people	Percentage in %	Number of people	Percentage in %
Child actions in an information threat situation								
Threat definition	32	0.4324	28	0.4058	61	0.8243	30	0.4348
Identification of the information security threat.	28	0.3784	25	0.3623	56	0.7568	24	0.3478
The IS threat analysis	21	0.2838	20	0.2899	39	0.5270	22	0.3188
Actions to resolve the IS threat situation.	16	0.2162	17	0.2464	37	0.5000	20	0.2899

To assess a statistically significant change in the correctness of the student's actions in an information threat situation between the control and experimental groups, the Fisher's test (Fisher's angular transformation) was used. As a result, on the basis of the data shown in Table 1, the following values were obtained, Fisher's tests, presented in Table 2, which show differences in learning the correct actions of fourth-grade students in situations of information threats

between the experimental and control groups before and after the experiment.

TABLE II. THE VALUE OF THE FISHER'S TEST FOR ASSESSING DIFFERENCES IN LEARNING THE CORRECT ACTIONS OF FOURTH-GRADE SCHOOLCHILDREN IN SITUATIONS OF INFORMATIONAL THREATS BETWEEN THE EXPERIMENTAL AND CONTROL GROUPS

Schoolchild actions in an information threat situation	The value of the Fisher's test (φ – Fisher's angular transformation)	
	Differences between the experimental and control groups	
	Before the experiment	After the experiment
Threat definition	0.3221	4.9985
Recognition of information security threats and threat class.	0.1992	5.0712
The IS threat analysis	0.0805	2.5387
Actions to resolve the IS threat situation.	0.4281	2.5913

Since the critical value for the 1% significance level is $\varphi_{kp} = 2.28$, it can be argued that if the levels of training coincide with the correct behavior of schoolchildren in situations of threats to their information security in both the experimental and control groups before the experiment (as evidenced by the value of the Fisher's angular transformation to experiment, which is less than the critical value equal to 2.28 for each child's action in an information threat situation), statistically significant differences in the child's training for each of his actions in the threat information situation after the experiment (as indicated by the value of angular transformation experiments after greater Fischer's critical value equal to 2.28, for each child action in the information threat situation).

IV. DISCUSSION OF RESULTS

We believe that the basis for the systematic training of primary school students in information security should be the study of material in typical situations of potential information threats. Based on the fact that the primary school student is just starting to get involved in productive mental activity, which requires him to maintain attention, focus, restrain emotions and perseverance, it is advisable to conduct information security training events in the primary grades in a playful way, with playing, social and psychological roles. Our approach is consistent with the results of the article J. Poos, K. Bosch, C. Janssen [13], which describes the features of critical thinking education and the role of game-based learning in the context of dynamic and static activities. As a result of the

implementation of this approach, a certain clear algorithm of behavior is formed in a child in a typical information threat situation.

During situated education, the schoolchild must learn to give an objective assessment of the information received to him, to be able to verify its reliability and truthfulness, on the basis of which to make the right decision, minimizing the risks of being cheated by attackers, causing harm to health and life threat.

From the moment of entering the school, threats to information security increase with respect to the child, as he has an ever-increasing degree of freedom from the field of view of his parents, the sphere of influence on the child of society, the family, the system of vocational education, and the school begins to differentiate. J. Plaza-de-la-Hoz, C. Caro emphasize the important role of parents in the formation of ethical standards, legal consciousness and safety of students in the process of using ICT tools [14]. Within the framework of situated information security education, it is possible to discuss with students issues of parental control of the use of the Internet and permission to visit certain electronic information resources W. Lau, A. Yuen [15].

The influence of the level of competence of teachers in the field of information security on the knowledge of students in this area is shown in the work of H. Chou, J. Sun [16]. Our study showed that teachers, together with parents, need to take appropriate measures to eliminate repeated situations of information threats.

The teacher's task in organizing situated education of information security for schoolchildren is to select situations, select participants, initially distribute roles and then control the course of events in the simulated situation. After the situation is completed, the teacher, together with the children, organizes a discussion of the correctness of the actions of the child suffering the educational information threat, considers possible scenarios and the consequences of the implementation of information threats, gives advice on how to best resolve the information threat situation with minimal damage.

V. CONCLUSION

Thus, the goal of the systematic training of information security for junior schoolchildren is to develop his skills in identifying the information threat to the individual and society and to help eliminate it as a result of actions based on standard algorithms.

The main tasks of teaching schoolchild information security in primary school include:

- the formation of children's motivation to gain knowledge in the field of information security;
- the development of abilities in reflection and reflection on his personality and the world around him;
- the training in ways of analyzing information that makes it possible to determine the negative effects on moral values, mental health, physiological condition;

- the assimilation of the concept of the information threat, on the basis of which the formation of skills to identify sources of information threats;
- the development of logical forms of thinking in children — actions according to an algorithm, conclusions, judgments.

As a result of an experiment in educational institutions in Moscow, St. Petersburg, Novokuznetsk on the implementation of a situated education system for the basics of information security for junior schoolchildren, they demonstrate a significant increase in the awareness of experimental groups of schoolchildren about personal information security and their readiness for action to protect one's identity and inner circle in situations of information threats.

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