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RECOGNITION OF PROBLEMATIC EDUCATIONAL SITUATIONS IN COMPUTER MODELING TRAINING

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Abstract. The article presents the results of the training in Computer Modeling in the third and fourth grades. Through the methods of participatory observation, interviews, discussions, surveys, and content analysis, data was collected, analyzed and systematized by teachers, principals, parents, university methodologists and IT administrators for problematic educational situations arising from technical reasons. An identification system was developed for their establishment. It is used to assess and measure changes in the complexity of the learning process and the workload of the teachers in the Computer Modeling subject in the event of problematic educational situations. In conclusion, guidelines for overcoming and resolving the identified unforeseen situations are provided.

Keywords: computer modelling; qualitative research; problematic educational situations

1. Introduction

1. 1. Statement of the problem

The paper examines how difficulties related to computer technology, software, system and application administration, specialized pedagogical work with computers, etc. affect the learning process in the Computer Modeling subject. Computer Modeling is a new subject, which is part of the general education in the third and fourth grades (Nikolov & Yankov 2018; Todorova & Krasteva 2021). The objectives of the training set in the curriculum are to build digital literacy by studying computer models for familiar objects, processes, and phenomena and by experimenting with them (Nikolov & Yankov 2018; Todorova & Krasteva 2021). It acquires knowledge, skills, and attitudes mainly in the field of digital competencies[1)] along with the implementation of interdisciplinary links (Gerdanikova, Stoitsov & Dimitrov 2021; Radev 2021). The experience gained before the introduction of the subject shows that such training is appropriate to be based on practical and applied tasks and less theoretical constructions (Garov & Tabakova-Komsalova 2017). According to some authors, the requirements for achieving expected results[1)] are as-

sessed as ambitious (Yovcheva 2018). This thesis is supported by the comparison of the curriculum content in Computer Modeling of Bulgarian third graders with that of similar subject of students in the United Kingdom, where the same concepts are studied and practiced for one school year in Bulgaria and for three years in British schools (Koleva 2019).

When introducing a new subject in the educational system, unforeseen circumstances and situations inevitably appear. Such situations when working with computer devices and software, which have led to a complication of the learning process and additional work by the teachers, we call Problematic Educational Situations (PES). These PES are the subject of the study.

1. 2. Aim of the study

The aim of the paper is to present a study, in which PES in relation to Computer Modeling that create obstacles to the learning process are identified and analyzed. The results were obtained through qualitative research on the methods of participatory observation, interviews, discussions, surveys, and content analysis conducted in the school year 2020/21 with data collected from 10 teachers, 2 principals, 118 parents, 3 university methodologists and 3 IT administrators from the private sector engaged in the maintenance of computer equipment and software at school.

2. Methodology

2. 1. Aspects, accents, specifics

The study methodology combines the application of the methods of participatory observation, interviews with teachers, discussions with school principals, software administrators and university methodologists, as well as analysis of questionnaires and literature. These methods are used to collect data, following a protocol for identification and systematization of PES. It consists of criteria for identification and evaluation of PES and indicators for measurement of changes in the complexity of the organization and management of the learning process and the additional workload of the teachers.

The study was implemented as a qualitative methodology. It often discusses and criticizes the way data is collected and summarized and the way results are interpreted (Belzile & Öberg 2012; Awasthy 2019; Waite 2014). The truthfulness of data and results in qualitative methods is ensured through approaches such as close interaction with people, reasoned interpretation, organizational efficiency, rigor of protocol preparation, criterion validity, validation of communication, and more (Lee 1999; Corbin & Strauss 2014). There is no consensus in the scientific literature on how to apply qualitative methods. It is common practice for the applied method to have an individual nature adapted to the specifics of the field, aiming to achieve close interaction between researchers and studied people. In our study, in parallel with the established methods and practices, an *approach to the identity of*

the confirmation of PES is also applied. Through it, the identification of the PES is established by several independent entities with different functions, roles and responsibilities for the learning process. For example, the establishment of PES upon participatory observation of teachers should be confirmed by a survey of the parents and interviews with the principals.

2. 2. Criteria and indicators

The elementary teacher of Computer Modeling often solves problems related to computer technology. In the study we analyze how this reflects on the organization and conduct of the learning process. For this purpose, the complexity of conducting a process of teacher training and workload is assessed based on comparisons between planned activities and responsibilities and those in the event of PES. We have tentatively accepted that there is a Unit of Basic Complexity and Workload characteristic of normal teaching practice. For established PES we measure the change in the complexity of training and the workload of the teachers. Data is obtained from teacher interviews. The measurements do not analyze pedagogical and methodological competencies. The Unit of Basic Complexity and Workload serves as a measurement unit of the change in the complexity of training and the workload of the teachers in the event of PES. In this sense, answers to general questions are sought, such as: "What additional activities, responsibilities and tasks does the teacher of Computer Modeling perform in case of PES?", "How does the teacher find solutions to PES?", "In what way and to what extent do PES change the learning process and engage the teacher?", etc.

Problem educational situations are identified and grouped according to four evaluation criteria:

K1) it is required to find a solution to a problem in a field other than pedagogy, which the teacher can handle;

K2) it is required to find a solution to a problem in a field other than pedagogy, which the teacher can solve provided that he or she acquires additional knowledge of computer device, computer network, software technology;

K3) there is a task that is unsolvable by the teacher without the help of an IT specialist;

K4) there is a long-term unsolved problem hindering the effectiveness of training, as a result of which the teacher accumulates psychological burden caused by working conditions.

The indicators for measuring PES have quantitative and qualitative characteristics. The scale compares the Unit of Basic Complexity and Workload and the changed Complexity and Workload upon an existing PES. The scale consists of measurements of change from Changed Complexity and Workload towards Unit of Basic Complexity and Workload:

– several times less (easier): with a coefficient over 2.5;

– less (easier): with a coefficient of 1.5 ~ 2.5;
– identical: with coefficient: 1 ~ 1.5;
– more complex (more difficult, more busy): with coefficient of 1.5 ~ 2.5;
– several times more complicated (more difficult, more busy): with coefficient of more than 2.5;

2. 3. Measurement formula

The evaluation criteria identify and group PES, while the scale of indicators measures the changes in the training process. These assessments of Changed Complexity and Workload (CCW) towards Unit of Basic Complexity and Workload (UBCW) are followed by sequence: the Changed Complexity and Workload is identified upon participatory observation, then verified by the confirmation identity approach, and then measured with interview responses. Data is additionally collected for the established PES for analysis from interviews with principals, system administrators and university methodologists or analysis of questionnaires. The specific measurement of teachers' answers is done according to the following formula:

CCW = UBCW + D/10 + CLP/10, where:
CCW is the Changed Complexity and Workload;
UBCW is the Unit of Basic Complexity and Workload conditionally accepted as 1;
Dis the difficulty in the emergence of a problematic educational situation;
CLP is the complexity of the learning process upon PES;

The formula is applied in the four groups of criteria by which PES are identified. For Difficulty and Complexity of the Learning Process teachers evaluate the changes with a number from 1 to 10. Thus, the Changed Complexity and Workload assumes possible values between 1 and 3, which are applied as a coefficient in the scale for measuring the Changed Complexity and Workload towards the Unit of Basic Complexity and Workload.

The measurement of the Changed Complexity and Workload is an indicator with which the primary teachers of Computer Modeling assess the problems in the teaching of the subject that have arisen on the occasion of technical reasons. The calculation of the Changed Complexity and Workload aims to trace whether there is a tendency to change the complexity of the learning process and the workload of the teachers upon identified PES. The function of the Changed Complexity and Workload is not to measure the complexity of the teaching and the workload of the teachers, but to measure their change.

3. Discussion of data and results

The analysis of the data aims at a deeper understanding of PES, while the quantitative measurements give a measure of the effect on the teaching and the work of teachers. Qualitative data is a description of problem situations that the teacher has encountered, for example: configuring tablet software during class. The study made

a number of sections on the changing complexity of the organization of the learning process and the burden on teachers with non-pedagogical engagement issues, such as: "How many astronomical hours do you spend during the week outside of your working hours to find a solution to a problem you encountered in class?" Such questions are aimed at obtaining information about the duration of PES during classes and the extracurricular activities of the teachers.

The established PES are united in three categories, namely: hardware and system software; application software and work on the Internet; material responsibility, communication with parents, as well as individual activities with students.

3.1. Hardware and system software

22 PES have been identified in this category. Their identity from the point of view of teaching is summarized as:

– shutdown of the computer device, damage to a peripheral device, interruption of the hardware component;

– the technical parameters of the computer devices in the school do not meet the system requirements of the application software intended for use in the educational literature;

– change of system settings of the operating system by a student;

– the computer device is infected with malware.

The analysis of the data presented in *Figure 1*, shows that PES with computer equipment and system software occurs approximately 3 school hours on 1 desktop computer with 13 work devices used by 103 students and 2 school hours on 1 tablet with 13 work devices used by 52 students. This means that every second lesson has a disrupted work plan and rhythm. The different criteria for PES established that:

K1) The process of training in Computer Modeling is more busy with a coefficient of 1.9 in 55% of the classes;

K2) For additional training and self-education, primary school teachers spend 1 astronomical hour per week on average training for 52 students and 13 work devices, and evaluate the preparation for the lesson as more complex with a coefficient of 2.1;

K3) The learning process is more difficult than the usual educational practices with a coefficient of 2.5 due to the emergence of unsolvable tasks for the primary school teacher.

K4) The tension during classes is higher by a coefficient of 1.5.

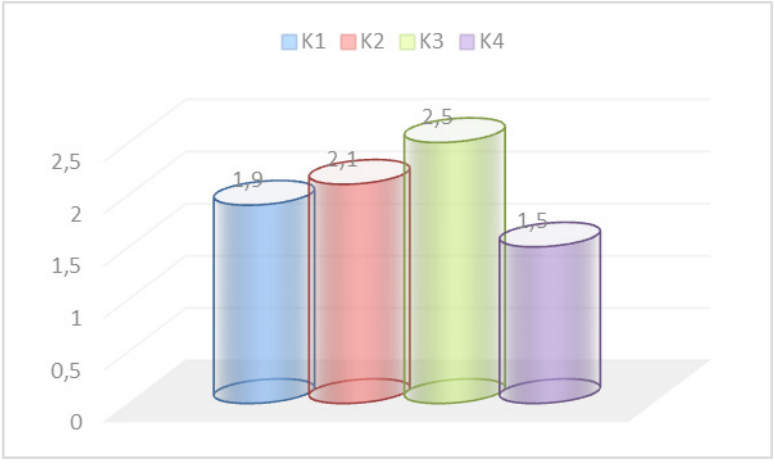

Figure 1. Hardware and system software category

3.2. Application of software and work on the Internet

38 PES summarized by identity have been identified in this category:

– inactive functionality of a web-based application;

– shutdown and failure of web browser and application software;

– problems related to registration and maintenance of student account and student avatar;

– installing, configuring, or setting up application software by students that interfere with learning;

– visits to web resources that are not safe for mental and physical health.

The research was done for the application software used for the purposes of Computer Modeling training. In the approved textbooks and exercise books of the Ministry of Education and Science for the school year 2020/21, it is recommended to study the visual programs Scratch[2)] and Code.org[3)], and in fourth grade in the section Programmable Devices Management – Lego[4)], Makecode[5)] and BeeBot[6)]. Some educators have chosen other programs, such as Kodugamelab[7)], and in the section Programmable Devices Management – Edison[8)]. The analysis of the data presented in *Figure 2* indicates that for web platforms, application software and student work on the Internet PES occurs for 1 lesson on 1 desktop computer with 13 work devices used by 103 students and for 1 lesson on 2 tablets with 13 work devices used by 52 students. This means that in every lesson there have been disruptions in the plan and rhythm of the work of the teachers caused by more than one computer device. In the individual groups of emerging PES the following was established:

K1) The process of training in Computer Modeling is more busy with a coefficient of 1.7 in 75% of the classes;

K2) For additional training and self-education, primary school teachers spend 1.5 astronomical hours per week on average training for 52 students and 13 work devices, and evaluate the preparation for the lesson as more complex with a coefficient of 2.4;

K3) The learning process is more difficult than the usual educational practices with a coefficient of 2.6 due to the emergence of unsolvable tasks for the primary school teacher.

K4) The tension in the class is higher by a coefficient of 1.6.

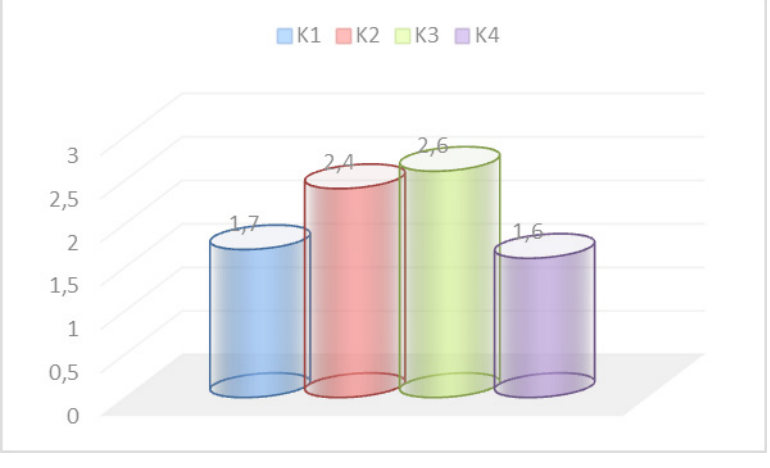

Figure 2. Application software and work on the Internet category

3.3. Material responsibility, correspondence and communication with parents, individual activities with students

In the category of criteria K2 and K4, 17 PES summarized by identity have been identified:

– inapplicable norms for material responsibility of the teacher for computer devices, especially when they are tablets;

– ignoring the need for cooperation with a teacher and part-time participation in the learning process by a high percentage of parents in cases where the student needs technical support at home;

– presence of students excluded from the learning process in topics with specific learning content.

The Preschool and School Education Act provides for parents to participate in the learning process[9]. In the training in Computer Modeling for children in the

third and fourth grades it is necessary to pay attention and apply a higher degree of control when working on the Internet. According to the surveyed teachers, two-thirds of parents are unaware of or ignore the dangers and needs of the child for a safe and secure Internet environment. This problem raises more general questions about personal responsibility and its sharing between parents and teachers. How far does the responsibilities of the teacher and the parent extent? Indirect involvement of parents in the learning process favors and positively affects the effectiveness of student learning (Stoeva 2022; Mihalev 2021). The authors of the paper also consider it necessary and useful to develop and implement mechanisms that engage the parent with responsibilities. From this point of view, individual topics of the Computer Modeling subject can be considered as a field of cooperation between teachers and parents given the future challenges and cultural needs of the presence of students in the web space.

4. Analysis of the results

In recent years, computer technology in primary schools has grown many times over. The increase in the volume of equipment is influenced by the gradual annual introduction of the subjects Computer Modeling in the third and fourth grades and Information Technology in the fifth, sixth and seventh grades[10)] during the 2018/19 school year. In parallel with the increase in the amount of computer equipment, schools are developing their own websites, local computer networks, video surveillance networks, and many more. This positive phenomenon for education is accompanied by a number of obstacles to the learning process related to the maintenance of computer devices and software. Deficits in hardware diagnostics and prevention, software installation, configuration, system and application administration of web applications and sites are compensated by teachers. Primary schools, especially with smaller teaching staff, where there are no software specialists or a qualified computer labsmanager, often lead to insurmountable problems. It is common practice at schools to enter into contracts with equipment maintenance companies, but the principle of "device is repaired only when it can no longer work" is widely followed. This is shared by principals, teachers, system administrators, and owners of school equipment maintenance companies. Reducing the existing problems in computer hardware and software has an effect on the learning process and the work of teachers and students. Apart from cases of non-functional and inefficient equipment, including discrepancies between hardware parameters and system requirements for newly provided tablets, teachers report: incompatibility of devices when recombining and editing already created Scratch projects when they contain videos, animation or specific character movements; failure of Scratch video player when changing the view from landscape to portrait; failure to navigate the tablet file system; unexplained interruption of Bluetooth connectivity; problems with the representation of graphic objects, etc. The essential thing in the manifestation of

such problems is that the primary school teachers do not have the competence and qualification to ascertain their specificity. They do not have a mechanism, nor are there any good practices in schools to address such problems adequately and in a timely manner. As mentioned, the manifestation of such problems leads to frequent PES, which requires a reduction in learning content, and sometimes leads to disruption of school hours. The direct effects on the learning process of the chaotic maintenance of computer hardware and software can be considered from several points of view: disrupting the rhythm of the learning process, increasing the volume of work, mental strain of the primary school teachers and demotivation of students.

Based on the analysis of the established several dozen PES, we can draw the following conclusions:

– The variable complexity of the training and the workload of the teachers in Computer Modeling depends on the state of the computer technology;

– The work of students with computer devices at school, including the Internet, is not protected by software solutions and good practices. Providing a safe environment for working on the Internet is limited to instructions and verbal recommendation from the teachers. In many cases, the responsibility is only on paper;

– Primary schools do not have the capacity, including qualified human resources and financial resources, to qualitatively administer computer equipment and software;

– Prevention, diagnostics and administration of computer equipment and software follows the principle "device is repaired only when it can no longer work";

– Frequent Problematic Educational Situations lead to disruption of the learning process in Computer Modeling and the creation of a psychological burden for the teachers;

– Overcoming Problematic Educational Situations in the training in Computer Modeling is closely related to the application of established practices of monitoring and prevention of computer devices and software.

5. Conclusion

From the many interviews conducted with teachers, principals, system administrators, university methodologists and surveyed parents, based on their opinions and positions, we concluded that: Primary schools do not have employees who have the necessary qualifications and competence to provide qualitative service of computer devices, software, networks, websites, and other tools and technologies provided and used for training purposes. For this reason, we believe that it is necessary to find a monitoring mechanism to assess the condition of the technical means provided for training, together with their maintenance. Should the schools be financially secured? Should external specialists with a higher level of qualification be sought? Should a monitoring and service system be set up under an institution of the Ministry of Education and Science or a local principle? All these are questions

open for discussion. However, they must be answered by bodies that are higher in the hierarchy of the education system than the individual schools. It is certain that now and in the future primary schools will need qualified specialists and financial resources to service computer equipment and software so that they can function effectively in the service of teachers, students, and the learning process.

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NOTES

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