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MILAN KLEMENT [1], **LUCIE BRYNDOVÁ** [2], **PETR ŠALOUN** [3]

Current Status and Readiness of Schools to Implement Teaching Aimed at Developing Computational Thinking

[1] ORCID: 0000-0001-9964-4057, Professor, Head of the Center of the Information and Education Technology, Palacký University Olomouc, Department of Technical Education and Information Technology, Czech Republic
[2] ORCID: 0000-0003-3534-7621, Ph.D., Associate Professor, Palacký University Olomouc, Department of Technical Education and Information Technology, Czech Republic
[3] ORCID: 0000-0001-9276-067X, Palacký University Olomouc, Department of Technical Education and Information Technology, Czech Republic

Abstract

Computational thinking and its implementation in the Czech national curriculum is currently one of the major challenges that the pedagogical experts are dealing with, not only in the context of the major revision of the Framework Educational Programmes for Primary Education.

The aim of the presented research work was to find out the current state of implementation of the revised Framework Curriculum Framework aimed at the development of computational thinking in Czech schools. Therefore, the conducted investigation mapped in more detail the attitude of teachers to the changes in the educational area of Informatics and whether they already teach according to the revised Framework of the Framework of the Curriculum, the extent of their knowledge and experience with the new content of this area and finally reveal the state of their working background. The preparation, course and results of this investigation are presented in the paper.

Keywords: Computational thinking, implementation, research investigation

Introduction

The teaching of computer science and related computer science subjects is becoming one of the core components of the modern educational system in modern society. The importance of this education is on a global scale comparable to subjects developing basic key competences (National Institute of Education, 2020; Ministry of Education, 2023), which are important for the personal development of an individual, his active participation in society and future employment in life (Lessner, 2014). The rapid development of digital and computer technologies, the global expansion of telecommunications infrastructure and its availability, the modernisation and automation of industry and other aspects of the so-called “computerisation of society,” are currently affecting all aspects of social life (Gates, 1997; Tapscott, 1998).

In response to this development trend, the topic of targeted development of competences related to the use and mastery of modern information and communication technologies has been opened in the field of pedagogy by educational experts (Perlis, 1962; Wing, 2006; CSTA&ISTE, 2011; European Commission, 2020). Currently, the priority in computer science education is precisely the introduction of teaching that aims at developing competences for the active and creative use of modern information and communication technologies (MoEYS, 2021). These skills are intended to enable students to use the full potential of modern technologies to solve problems and automate specific processes, and to develop their ability to adapt to technologies that are yet to be implemented in society in the future (Wing, 2006; MoEYS, 2014).

The need to integrate the development of IT and digital competences into basic education has long been considered as one of the main educational priorities in Europe and beyond (European Commission, 2020; Ala-Mutka, Punie, Redecker, 2008). Thus, shifting the focus of national curricula towards integrating the principles of teaching that will lead students to actively use digital and information technologies, rather than simply consuming digital content, is currently a major strategy of education policies around the world, along with the development of key competences such as critical and creative thinking and other effective problem-solving skills. In this context, the term “computational thinking” from the English “computational thinking” is increasingly emerging. This concept, which has gained global prominence in the past decade (Lessner, 2014), reflects the need for human populations to adapt to a new technological era based on the integration of information technology into all areas of life.

The issue of introducing the targeted development of computational thinking into national curricula has been an accentuated topic for the last decade among experts who have been exploring the possibilities of changing the overall concept of teaching in basic education to meet the demands placed on individuals by the modern digital society. Since 2006, when Jeannette Marie Wing first presented her definition of computational thinking, the issue has been discussed at a number of summits and has become a key educational goal of many organizations and federations (WSIS, ACM, IFIP, EC). Especially abroad, it has become a major trend in key curriculum revisions dating back to 2012 (The Royal Society, 2012).

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The state of implementation of informatics thinking in the Czech Republic

In the Czech environment, the implementation of computational thinking is still a relatively new issue, although its basic principles have already appeared earlier. The integration of the targeted development of pupils' skills, which should lead to the safe and creative use of digital and computing technologies, is unquestionably a long-term goal of the domestic curriculum strategy. References to a set of skills that can be understood as components of computational thinking, as well as the development of programming skills, have been mentioned in previous education policies (Klement, 2018; MoE, 2014).

The development of computational thinking became a standard part of the primary curriculum only in 2023, after the revision of the Framework Educational Programme for Primary Education (RVP ZV), by the Minister's measure No. MSMT-12464/2023 on the revision of the RVP ZV with effect from 1 September 2023. In accordance with this revision, primary schools in the Czech Republic are obliged to start teaching that will be in line with the revised RVP ZV and will be aimed at the development of pupils' computational thinking. However, this change comes practically a full decade after the first recommendation of the European Commission, which called on member states to integrate the development of computational thinking in schools (CSTA & ISTE, 2011) and with a significant delay compared to neighbouring European countries (Bocconi *et al.*, 2018).

The revision of computer science and related subjects in the domestic environment has long faced technical challenges as well as social and political difficulties. In recent decades, there have been rapid developments in computing technologies and related definitions and understandings of concepts closely related to the teaching of computer science. The very notion of computer science and other related subjects has also evolved in response to domestic social and market demands. These changes, which in some cases have affected the overall domestic understanding of the concept of informatics in education, have contributed to slowing down the process of development of a school system in which the inclusion of teaching aimed at developing programming skills and computational thinking is considered a sign of modernity (European Commission, 2022).

On a global scale, it is evident that the revisions flowing towards the integration of computer science in the basic education curriculum are characterized by a diversity of conceptions of their implementation. Especially when it comes to the integration of targeted development of programming-related skills, a wide range of different educational policies can be encountered. These differences stem from differences in the economic and technological background of schools in a given country, in the different didactic approaches to teaching, in the individual organization, form and content of educational activities, and in the qualifications and training of teachers (Román-González *et al.*), In this respect, the

Czech environment, which did not have a widely established curricular tradition of programming in primary education before the revision, falls into the category of countries where the transition to teaching towards the development of computational thinking is difficult (Klement, Dragon, Bryndová, 2020).

Focus of the research investigation and its objectives

The aim of the research investigation was to determine the current state of implementation of innovative informatics, which is part of the updated RVP ZV aimed at the development of computational thinking, into teaching in primary schools. In addition to the main objective, sub-objectives were set to ascertain the opinions and knowledge of teachers in the different areas of innovative informatics. In relation to the above objective, the main research questions were set.

1. Are teachers familiar with the Primary Education Framework for the Development of Computational Thinking and does teaching take place according to it?
2. Do teachers have knowledge in the three main areas of innovative informatics and do they agree to teach them?
3. Do teachers have sufficient facilities at their school for teaching innovative informatics?

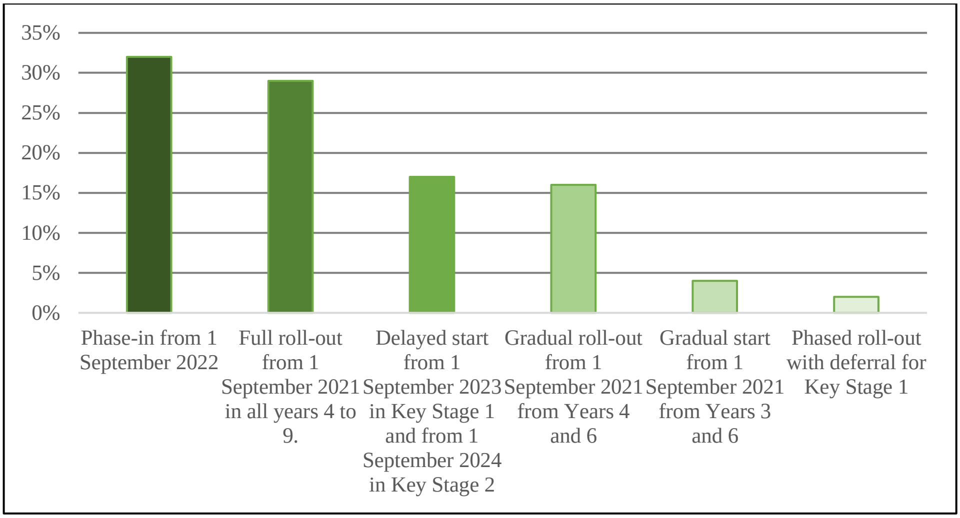
Characteristics of the survey

The research investigation was conducted using quantitative research, specifically an anonymous online questionnaire was used (Chráska, 2016). The research was focused on primary school computer science teachers, therefore the link to the questionnaire form was distributed via email only to specific computer science teachers, which were searched on the websites of individual primary schools across the country.

The questionnaire consisted of 17 closed and 3 semi-closed questions, all questions were mandatory, it was not possible to skip any of them. For clarity, the questions were further divided into 5 sections – Basic Information, Programming and Algorithmization, Basics of Educational Robotics, Computer Science (working with data, coding, basics of computer science) and Status of Hardware and Software in the School. The first section included basic questions on gender, length of experience, school size, endorsement, familiarity with the upgraded RAP, and the respondents' school's start-up to teaching upgraded computer science. The subsequent 3 sections contained the same concept of four questions adapted to each of the three areas of upgraded informatics – programming and algorithmization, educational robotics and computer science. The final fifth section asked about the state of the hardware and software in the respondents' workplaces.

Selected results of the survey

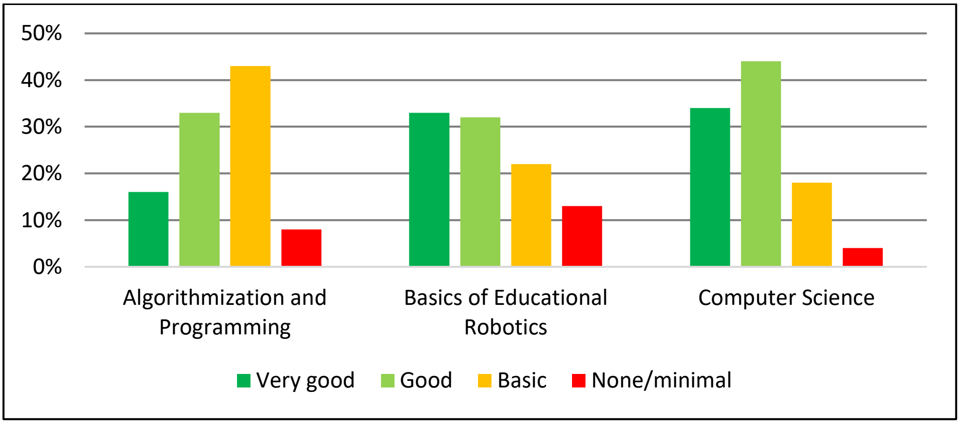
The first question that was included in the basic data section was the question *What is your school's take-up of teaching informatics according to the updated RVP ZV?* Here it was investigated in what way individual schools are taking up the teaching of the upgraded informatics. Teachers chose the option that most closely matched the situation in their workplace from six options. They were also provided with pictures describing the different approaches in more detail. The majority of respondents chose the option of a gradual start of the teaching of innovative informatics at the beginning of the current school year, i.e. in September 2022, namely 65 (32.2%). For 58 (28.7%) respondents, the full start of teaching in all grades already took place in September 2021. The postponement to 2023 for grade 1 and 2024 for grade 2 was chosen by 35 (17.3%) of the schools where the respondents work. The last most frequent response was a phased start from 2021 in Years 4 and 6, with 33 (16.3%) of respondents choosing this option. The remaining 11 respondents were split between the options of a phased rollout from 2021 in Years 3 and 6 and a phased rollout with a delay for Year 1, with 8 (4%) respondents selecting the first option and 3 (1.5%) selecting the second option as shown in the graph below.



Graph 1. On-boarding for the teaching of innovative informatics

From the chart it can be seen that more than half of the schools surveyed were involved in teaching innovative informatics right from the start. The remaining part is waiting for the onset of the new teaching content for understandable reasons such as caution, lack of experience or untrained teachers. This may also be due to the lack of the necessary material and non-material didactic aids.

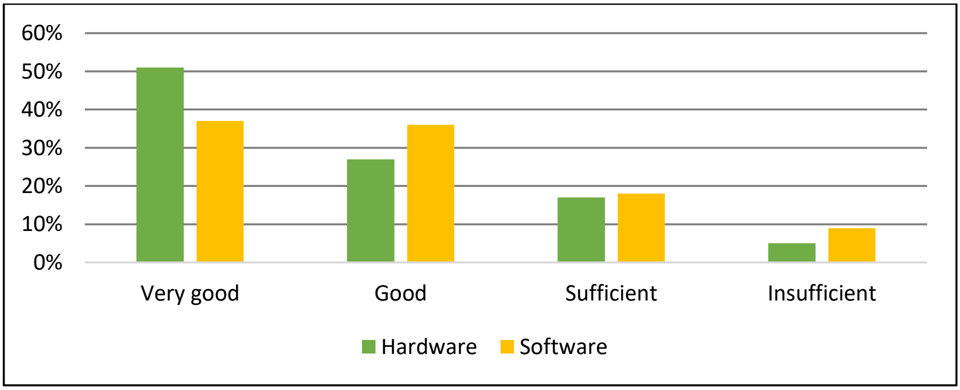
In the next part of the research, we asked about their knowledge in particular areas covering new informatics. First, respondents answered the question: *What is your knowledge in programming and algorithmization?* Most of the respondents, i.e. 86 (42.6%) answered that their knowledge is rather basic. 67 (33.2%) of the respondents are at a good level, i.e. they know at least one programming language, 32 (15.8%) of the respondents are even at a very good level. Only 17 (8.4%) out of 202 respondents have no or only minimal experience with programming and algorithmization. The second question was again used to determine the teachers' knowledge, this time in the field of educational robotics. We also investigated their level of knowledge in educational robotics by asking, *What is your level of knowledge in educational robotics?* All 202 (100%) respondents answered, of which 66 (32.7%) chose "Very Good". Only one less respondent, 65 (32.2%), chose "Good" and 45 (22.3%) teachers chose "Basic". The lowest number of responses, 26 (12.6%), was for "I have minimal/no experience with educational robotics". The last part of this part of the survey was to determine teachers' knowledge of general computer science. All 202 (100%) of the respondents answered the question *What is your knowledge of data handling, coding, and basic computer science?* Respondents chose from four options. The option with the highest number of responses was "Good", with a total of 89 (44.1%). 68 (33.7%) teachers rated their knowledge as "Very Good" and 36 (17.8%) found their knowledge to be at the "Basic" level. 9 (4.5%) respondents rated their knowledge in this area as "Minimal/None". A graphical summary of the findings is presented in the chart below.



Graph 2. On-boarding for the teaching of innovative informatics

It can be seen that most respondents are rather basic in the area of algorithmization and programming. However, the implementation plan took this information into account and therefore offered various types of training and courses related to programming. Thus, the new concept of teaching computer science, specifically the area of programming and algorithmization, is not based on complex programming languages, yet in our opinion it is desirable for the teacher of this subject to know at least 1 programming language. Above all, it is necessary to understand the principles of programming and algorithmization in order to properly convey them to the students. However, less than 16% of the respondents with very good knowledge are very encouraging, but the question remains whether they have a good command of the ability of didactic transformation – i.e. to translate their expertise into learning.

Using the last section of the questionnaire presented here, we collected information about the background of teachers in the area of IT equipment at their workplaces. This section contains two questions, one related to hardware, the other to software. For both questions there were four options to choose from. The question, *What is your opinion about the hardware in your school for teaching upgraded computer science? (computers, data projectors, robotic kits, interactive whiteboards, tablets, etc.)*, more than half of the respondents gave the option "Very good", a total of 102 (50.5%). 55 (27.2%) teachers rated their IT equipment as "Good". 34 (16.8%) of the respondents selected "Sufficient" and 11 (5.4%) of the teachers selected "Insufficient" IT equipment at their place of work. The level of software equipment at the workplace was ascertained by the question, *What is your opinion about the software equipment in your school for teaching innovative informatics? (licenses, programs, study materials in electronic form, etc.)?*, it surveyed the opinion of teachers about the software facilities in the primary schools where they work. 75 (37.1%) teachers rated their software facilities as "Very good", 72 (35.6%) would rate it as "Good". 37 (18.3%) respondents marked the option "Sufficient". According to the survey, the least number of teachers have "Inadequate" software facilities at their place of work. Again, a graphical summary of the findings is presented in the chart below.



Graph 3. Teachers' views on hardware and software equipment at school

If we compare the responses of the respondents in the above chart, we find that the number of "very good" responses has significantly decreased at the expense of the other responses. Thus, we can say that although a large number of schools have very good HW equipment, their SW equipment is rather good or sufficient. This can be attributed to the difference in the purchase of HW and SW equipment. HW equipment very often requires only a one-off purchase and commissioning. The purchase of SW equipment is slightly more complex. Licences for various products are often time-limited and require renewal, which is a significant financial burden for schools.

Conclusion

The aim of the research was to determine the status of implementation of the revised RVP ZV aimed at the development of computational thinking in Czech schools. The sub-objectives furthermore mapped in more detail the attitude of teachers to the changes in the educational area of Informatics and whether they already teach according to the revised RVP ZV, the extent of their knowledge and experience with the new content of this area and finally reveal the state of their working background. On the mentioned objectives we will further note the conclusions resulting from the answers of the respondents. A total of 202 computer science teachers with different levels of education and length of experience participated in the questionnaire survey.

Based on the survey conducted, it can be said that the implementation of the curriculum aimed at developing computational thinking is at a good level. Although there are schools that wait until the deadline to implement, a large number of schools started teaching the new content right from the beginning. In terms of teacher knowledge, most teachers are adequately prepared for teaching. Of course, there are also individuals whose knowledge is at a minimal level, but training on the subject is increasing, so these teachers have the opportunity to acquire new knowledge.

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