ICT competencies and their development in primary and lower-secondary schools in the Czech Republic

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Abstract

The paper reports on the conception and the main summary results of the research project “Children's Information Technology Competencies and Their Development in Primary and Lower-secondary Schools”. The research project focused on a complex issue of informatics, or information technology education and ran in more than 1000 primary and lower-secondary schools in the Czech Republic in 2013. The primary aim of the project was to identify the current state, structure and orientation considering the curriculum, process and organisation aspects of the pupils’ information technology competencies development in terms of developing a particular level of their broadly defined informatics, or ICT literacy. The research was broken down into five areas focused on the characteristics of informatics learning activities, content of informatics learning activities, current state and concept of pupils’ information technology competencies development, structure of teachers’ ICT competencies, and implementation of information technology competencies development into educational school environment.

Introduction

In the group of key competencies understood as a specific combination of knowledge, skills and attitudes, which people should acquire for their personal fulfilment and development, active citizenship, social cohesion and working life (European Parliament and the Council, 2006), information technology competencies have a significant place and are a foundation for broad understanding of the information, information technology, or ICT
Primary and lower-secondary schools have undoubtedly a particularly significant role in providing information technology education and targeted development of information technology competencies, or individual cognitive and operational skills and attitudes necessary for the effective use of information and communication technologies. Informatics or information technology education as a standard part of the primary and lower-secondary school curriculum is a feature of school systems of developed countries (Ala-Mutka, 2011). However, the approach to teaching thereof is not uniform. On the one hand, there is a wide range of approaches characterized by reducing informatics education to practising the use of specific software tools mainly for searching and processing text information; on the other hand, there are approaches emphasizing the development of pupils’ digital literacy, critical, creative and informatics thinking. Differences can be assumed also between the programme declarations and understanding goals and tasks and content transformation and concretization of the educational activities of schools and teachers whose didactic approaches, professional and ICT skills can differ.

The concept of contemporary information technology education must support the development of abilities, or competencies enhancing pupils’ adaptability, knowledge and skill transfer into new contexts and the ability to learn in a rapidly changing environment. It must develop pupil’s critical thinking, their ability to decide and argue reasonably, develop informatics and algorithmically thinking and problem-solving; it must develop pupils’ creative thinking and encourage their creativity (Ala-Mutka, 2011; Ferrari, 2012).

In this context, in 2012 and 2013 researchers from the Faculty of Education, Charles University in Prague realized a research project "Pupils' Information Technology Competencies and Their Development in Primary and Lower-secondary Schools" (VIV12), supported by the Czech Science Foundation grant. The research focused on the issue of informatics, or information technology education in Czech primary (ISCED 1) and lower-secondary (ISCED 2) schools and its target group included both the teachers of informatics subjects and their pupils. 1183 primary and lower-secondary schools from all regions of the Czech Republic joined the project through their teachers and pupils (Rambousek, Štípek & Wildová, 2012).

Aims and methods of the research

The "Pupils' Information Technology Competencies and Their Development in Primary and Lower-secondary Schools" research project was running from January 2012 until December 2013. The research focused on the issue of informatics, or information technology education at primary and lower-secondary schools in the Czech Republic and its target group consisted of teachers of informatics subjects and their pupils. The subject of the research was broken down into five areas focused on the (a) characteristics of informatics learning activities, (b) content of informatics learning activities, (c) current state and concept of pupils’ information technology competencies development, (d) structure of teachers’ ICT competencies, and (e) implementation of information technology competencies development into learning activities and educational school environment.

The primary aim of the project was to identify the current state, structure and orientation considering the curriculum, process and organisation aspects of the pupils’ information technology competencies development in terms of developing a particular level of their broadly defined informatics, or ICT literacy.

During the project, within an extensive exploratory survey, both empirical quantitative and qualitative methods were used in addition to theoretical methods. The questionnaire method was used as a primary empirical research method. It was based on an interactive graphic questionnaire for 3500 teachers of informatics subjects, in which research data were obtained from 1183 teachers representing individual primary and lower-secondary schools (54% of respondents were women, 46% men). The questionnaire for teachers included also an invitation to participate in the second empirical phase of the research based on a survey for teachers, a questionnaire for pupils and case studies. 167 teachers of informatics subjects, 52 % of whom were women, 48 % men, representing 167 primary and lower secondary schools accepted the invitation and registered into the system.

In the second phase of the project, a survey method was applied, in which data were obtained from 84 teachers of informatics subjects. The electronic survey was completed by 84 teachers of informatics subjects (48% women and 52% men). In addition to this, a questionnaire for pupils was distributed, which was completed by 2173 pupils from 112 primary and lower secondary schools. The pupil’s questionnaire was completed by 2173 pupils from 112 primary and lower secondary schools. 48% of respondents were girls, 52% boys. As for the age group,
28% respondents were from the 6th grade, 29% from the 7th grade, 20% from the 8th grade and 23% from the 9th grade. The last applied empirical method constituted a case study method used at 6 primary and lower secondary schools. Case studies were based on school tour, classroom observations, talks with pupils and an interview with a teacher of informatics subjects (Štípek, Rambousek & Procházka, 2013).

Main summary results

Although 3,500 schools were randomly selected out of the total of primary and lower-secondary schools in realisation of research project and the extent of the sample was considerable and in many parameters the sample corresponded with the overall distribution of the indicators, it was not possible to ensure due to the voluntary participation in research full representativeness of the sample corresponding with the random sampling. The results below can be, therefore, related to the given sampler of respondents, the generalization and judgments should be made very carefully. Overall, based on the findings of the applied research methods in connection to observed curricular, processional and organizational aspects of ICT literacy education in primary and lower-secondary schools in the Czech Republic bearing in mind the above mentioned limited representativeness of the sample respondents, we can say (Černochová et al., 2013; Rambousek & Štípek, 2014):

1.1. Characteristics of informatics learning activities

Informatics learning activities focusing on developing children's information technology competencies are used across the whole monitored spectrum in primary and lower-secondary schools, i.e. as compulsory and non-compulsory informatics subjects, through employing informatics topics or digital technologies in other subjects and through conducting informatics-orientated projects.

A compulsory informatics subject is the most common form of informatics learning activities in primary and lower-secondary schools. It is taught in 90% of primary schools and in 97% of lower-secondary schools.

Using digital technologies in other subjects with no particular focus on the development of children's information technology competencies constitutes the second most frequent form. Yet, in 16% of primary and lower-secondary schools children do not encounter digital technologies outside informatics subjects at all.

Two thirds of primary and lower-secondary schools do not make use of project based learning, or informatics-orientated projects, to develop children's information technology competencies.

Informatics topics are implemented into various subjects and informatics-orientated projects are conducted in lower-secondary schools twice as often as in primary schools.

In primary schools, a compulsory informatics subject receives solely a minimum time allocation of one lesson according to the Framework Educational Programme FEEP.

In lower-secondary schools, a compulsory informatics subject is usually taught from Year 6. However, in all other grades the compulsory informatics subject is taught approximately in half of the lower-secondary schools.

In lower-secondary schools, a compulsory informatics subject is taught more than one lesson a week in more than one grade. We may assume that a significant amount of schools decided to extend the minimum time allocation of Information and Communication Technologies in their SEP by an extra lesson, or lessons.

Most of the respondents consider the content of FEEP in the educational field of Information and Communication Technologies as too general and half of them criticize its concept due to the lack of current content or overall inadequacy of the concept. Above all, the document should be modified in terms of the increase of a time allocation, better specification of the content and in terms of its extension and innovation.

The concept of FEEP is supplemented or modified in SEPs primarily in terms of extension, enrichment and innovation of the curriculum. SEPs are also modified with the aim to provide informatics subjects and topics more time considering their importance for the development of particular children's competencies. However, app. 85% respondents consider the time allocation for the informatics subject in the school curriculum as insufficient.

Pupils do not like working with office applications, particularly with spreadsheets. Other topics, such as theory of informatics, hardware and programming are not enjoyable for them, either. In addition, they are not happy with low demands placed on them in the lessons, and also with boring and insufficiently variable work in class.
During the lessons of informatics subjects, children mostly enjoy a free activity. However, they usually spend this time playing games and chatting on social networks. They also like creative activities when working with graphics and multimedia, searching information on the internet, practical work with programmes, and they also report satisfaction from learning something new.

1.2. The content of informatics subjects

Among the primary thematic units evaluated by the respondents, the following thematic units are of the greatest importance for the development of children’s information technology competencies ranked from the most significant one, resp. from the highest average score on 0 - 100 scale as $M =$ median and deciles ($1 - 10$):

- Searching for and retrieving information from the internet, data collecting ($M = 94, Q = 9 - 10$)
- Safety on the internet, copyright, ethical principles ($M = 93, Q = 8 - 10$)
- Word processing – creating and editing documents, basics of typography ($M = 90, Q = 8 - 10$)

Respondents consider also the following thematic units as significant for the development of children’s information technology competencies:

- Basic user skills, working in an operating system, file management ($M = 81, Q = 7 - 10$)
- Creating and using presentations – working with presentation applications ($M = 77, Q = 6 - 10$)
- Communication and cooperation in digital environment ($M = 74, Q = 6 - 9$)

From the viewpoint of developing primary and lower-secondary school children’s information technology competencies, they see as the least important thematic units of informatics subjects the following thematic units ranked from the least important unit:

- Algorithmisation and basics of programming - developing algorithmic thinking ($M = 20, Q = 2 - 6$)
- Database basics – creating and using databases ($M = 22, Q = 1 - 5$)
- Creating and publishing www pages (HTML, CSS, PHP, etc.) ($M = 29, Q = 1 - 5$)

The structure of the respondents’ information technology competencies significantly affects the choice of the key and inessential units. Respondents very often see the units that they master themselves very well as key units. Conversely, the units, for which they have their information technology competencies at a lower level, they see as inessential ones.

From the viewpoint of the content of the compulsory informatics subject, respondents consider the following thematic units ranked from the most important one as key and essential (keep or give up):

- Word processing – creating and editing documents, basics of typography (keep 86.3 %)
- Searching for and retrieving information from the internet, data collecting (keep 79.1 %)
- Safety on the internet, copyright, ethical principles (keep 58.8 %)

The following thematic units ranked from the least important one are considered by the respondents as inessential from the standpoint of the content of the compulsory informatics subject (keep or give up):

- Database basics – creating and using databases (give up 80.9 %)
- Creating and publishing www pages (HTML, CSS, PHP, etc.) (give up 73.4 %)
- Basics of information theory (e.g. types, size, sources, storing, transfer) (give up 62.3 %)
- Working with sound and videos on the computer - using and creating multimedia (give up 58.0 %)
- Algorithmisation and basics of programming - developing algorithmic thinking (give up 51.9 %)

In primary school, children’s information technology competencies should be primarily developed in the following thematic areas according to the respondents:

- Safety on the internet, copyright, ethical principles
- Word processing – creating and editing documents, basics of typography
- Searching for and retrieving information from the internet, data collecting
- Basic user skills, working in an operating system, file management

A vast majority of primary school teachers do not focus on Algorithmisation and basics of programming, whereas they believe that it is appropriate to introduce this topic as late as in upper-secondary school. Respondents also postpone the development of children’s competencies in the thematic units such as Creating and publishing websites and Database basics until upper-secondary school.
From the viewpoint of time allocation, the following thematic units are prioritised in most primary and lower-secondary schools ranked from the unit with the highest time allocation:

- Word processing – creating and editing documents, basics of typography (most 87.9%)
- Searching for and retrieving information from the internet, data collecting (most 64.6%)
- Safety on the internet, copyright, ethical principles (most 55.4%)
- Creating and using presentations - working with presentation applications (most 55.4%)

Respondents with a higher level of information technology competencies incorporate into the lessons more topics that are not contained in the particular FEP EE area and can be considered supplementary, additional, innovative or promising.

As regards the importance of the thematic units of informatics subjects pupils put internet related topics at the centre, including both searching for information and safety on the internet. Pupils consider topics that require systematic efforts, memorising and a greater degree of logical reasoning as less important, tedious and difficult. That is how they rate the Creating and Publishing Websites, Programming or Spreadsheets thematic units.

Pupils are even able to clearly identify the importance of topics they otherwise regard as difficult and boring. Practically all pupils consider internet Security topic as important in spite of the fact that the vast majority of them do not enjoy it.

1.3. The concept of information technology competencies development and its status

The following are believed to be the most important competencies to be developed among the higher degree of generality competencies for building and development of information technologies literacy of primary and lower-secondary school pupils (ranked from the most important one, resp. from the highest average score on 0 - 100 scale as A = arithmetic mean):

- Search for and obtain information (A = 90.0)
- Respect the rules of behavior in the digital environment (A = 84.7)
- Evaluate and analyse obtained information and distinguish important information (A = 81.6)
- Process and integrate information (A = 78.4)
- Present information and process it for the given purpose and recipients (A = 76.9)
- Communicate and cooperate in digital environment (A = 76.4)
- Master digital technologies (A = 75.9)
- Think creatively, create your own products (A = 74.8)

The following are believed to be the least significant competencies among the competencies of a higher level of generality for building and developing information technology literacy of primary and lower-secondary school pupils (ranked from the least significant competency):

- Understand technological principles and processes (A = 47.3)
- Think algorithmically, formulate orders and instructions (A = 53.3)
- Know how to use problem-solving strategies and information orientated tasks (A = 59.4)

The following are believed to be the most significant competencies among the competencies of a lower degree of generality for building and developing information technology literacy of primary and lower-secondary school pupils (ranked from the most important competency, resp. from the highest average score on 0 - 100 scale as A = arithmetic mean):

- Create, edit and process documents in a word processor (A = 85.4)
- Use various information sources for information verification (A = 81.2)
- Navigate through various forms of information (graph, table, scheme, document…) (A = 79.9)
- Judge reliability and credibility of electronic information sources (A = 78.3)
- Understand social, ethical and cultural impacts of ICT use (A = 71.6)

The following are believed to be the least important competencies among a lower degree of generality competencies for building and development of information technologies literacy of primary and lower-secondary school pupils (ranked from the least important competency):

- Master the basics of algorithmisation and programming (A = 30.3)
• Create websites in HTML, PHP, JavaScript etc. languages \((A = 31.4)\)
• Complete and create and use mind and concept maps \((A = 51.4)\)
• Create tables and graphs in spreadsheet and make use of them \((A = 65.9)\)

The way respondents perceive the significance of information technology competencies reflects their attitude to similarly orientated thematic units of informatics subjects.

• Competencies related to thematic units regarded by respondents as the key competencies are perceived as very important.
• Competencies related to thematic units marked most often by respondents as inessential ones and at the same time identified as the ones for which respondents lack sufficient ICT competencies were considered of little importance.

From the viewpoint of the characteristics of the current state of the development of information technology competencies of primary and lower-secondary school pupils, respondents primarily seek to develop among the competencies of a higher degree of generality the following competencies (ranked from the most important one, resp. from the highest average score on 0 - 5 scale as \(A = \text{arithmetic mean}\):

- Search for and obtain information \((A = 4.6)\)
- Respect the rules of behavior in the digital environment \((A = 4.1)\)
- Process and integrate information \((A = 4.0)\)
- Present information and process it for the given purpose and recipients \((A = 3.8)\)
- Master digital technologies \((A = 3.7)\)

Generally speaking, respondents regard as very important the competencies, the development of which they can influence within the information technology learning process. Simultaneously, respondents regard as important the competencies that include working with information.

Among the competencies directly related to working with information, the following competencies are developed to the greatest extent in primary and lower-secondary schools (ranked from the most important competency):

- Search for and obtain information
- Evaluate and analyse obtained information and distinguish important information
- Present information and process it for the given purpose and recipients
- Process and integrate information

Respondents declare that they manage to achieve the goals and intentions of SEP to build and develop pupils' information technology competencies, in many cases also with the help of other subjects. Above all, they see adequate technical equipment and teachers' qualification and their level of expertise as necessary conditions for achieving goals and intentions of SEP from the standpoint of building and developing pupils' information technology competencies. In contrast, they identify insufficient technical equipment and a lack of finances for its development and teachers' low qualification and their level of expertise as the main obstacles. As other obstacles they identify a low time allocation for the informatics subject, pupils' lack of interest and reluctance and colleagues' and leadership's weak support.

In the lessons of a compulsory informatics subject, respondents usually apply a combination of methods and teaching techniques, or they encourage pupils' practical work if possible with outcomes interesting for pupils, or useful in practice. Individual practical work, individual approach to pupils, supporting pupils' interest in learning and creating practical outcomes have proved successful.

1.4. The structure of teachers' information technology competencies

As regards expert skills, or the level of information technology competencies, two fifths of the teachers of informatics subjects report the level that they themselves consider as the lowest still acceptable for high quality teaching of informatics subjects in primary and lower secondary schools and two fifths report a higher level. One fifth of the respondents do not consider their information technology competencies as sufficient for teaching informatics orientated subjects in primary and lower-secondary school.
Basic user skills represented by the thematic units such as word processing, using spreadsheets, processing presentations, basic administration of an operating system, searching information on the internet and using digital technologies as communication means are viewed through the lens of thematic units as a solid base of the extent of teachers’ information technology competencies. Three fifths of teachers do not go beyond this base.

Basic information technology competencies related to the following topics can be considered a usual part of the respondents’ professional portfolio (ranked according to the occurrence of the answer “I want to stand in for another teacher”):

- Word processing – creating and editing documents, basics of typography (79%)
- Searching for and retrieving information from the internet, data collecting (73%)
- Safety on the internet, copyright, ethical principles (69%)
- Creating and using presentations – working with presentation applications (59%)
- Working with spreadsheets – processing data, creating tables and graphs (52%)
- Computer hardware and software (45%)
- Basic user skills (44%)
- Communication and cooperation in digital environment (41%)

Differences in the full extent and structure of information technology competencies are seen among respondents primarily in the level of the following thematic units, which are also perceived as primary differentiation factors:

- Working with computer sound and video – using and creating multimedia
- Basics of information theory (e.g. types, size, sources, storing, transfer)
- Creating and publishing websites (HTML, CSS, PHP, etc.)
- Database basics – creating and using databases

The level of teachers’ competencies ranges from basic user skills to advanced competencies concerning more demanding areas of algorithmic-formalisation nature. At the same time it is true that the differences among the respondents are relatively significant and we may thus assume significant differences in the level and concept of information technology learning in primary and lower-secondary schools.

Children’s statements in which they question the expertise of teachers of informatics subjects in primary and lower-secondary schools are not unfortunately unique.

1.5. The implementation of digital technologies into the school learning environment

The implementation of digital technologies and activities supporting children’s information technology competencies development into school life and learning environment is realized primarily in the following directions (ranked from the most frequently used type of implementation, resp. from the highest average score on 0 - 5 scale as M = median and A = arithmetic mean):

- Pupils use ICT during the learning process in various subjects \( (M = 5, A = 4.3) \)
- Teachers use ICT to prepare their lessons and create their teaching materials \( (M = 4, A = 4.3) \)
- Teachers use ICT to support the learning process in various subjects \( (M = 4, A = 4.2) \)
- ICT are available at school and pupils can use ICT also after school \( (M = 4, A = 3.7) \)
- Pupils create and submit their work electronically \( (M = 3, A = 3.4) \)

The following types of the implementation of ICT and the activities supporting children’s information technology competencies development into the school life and learning environment are only partially applied (ranked from the more frequently applied type of implementation):

- Teachers use ICT to plan, organise, check and evaluate their teaching \( (M = 3, A = 3.2) \)
- Pupils create electronic materials to support their learning process \( (M = 3, A = 3.1) \)
- Teachers use ICT to communicate with children and parents and to send materials \( (M = 3, A = 3.1) \)
- Pupils communicate with their teacher electronically \( (M = 3, A = 3.0) \)

Learning projects using digital technologies are rarely realized in primary and lower-secondary schools. Virtual learning environment (VLE, LMS) is used the least often of all monitored ways of implementation.

The implementation of digital technologies and activities supporting children’s information technology competencies development into school life and learning environment thrives primarily in the fields that do not place
extra time or qualification demands on teachers or that, on the contrary, despite initial extra time investment make teachers’ activities in a way more effective in future instead.

The significance of the particular way of implementation is not primarily a determining factor of the levels and directions of ICT implementation and activities supporting the development of children’s information technology competencies into school life and learning environment. Teachers mainly use the ways and directions of implementation that do not place extra time or qualification demands on teachers or that conversely despite initial extra time investment make teachers’ activities in a certain way more effective in future.

Teachers use digital technologies largely to prepare their own teaching contents. They share their successful contents and they work on their improvement along with other teachers, or they publish them on the internet. Children also start getting involved increasingly well in the development of the materials.

Websites are a usual part of school presentation, which are becoming part of school life, and they help to illustrate its overall atmosphere. Parents start contributing as well.

The vast majority of children get ready for the class using the internet and only a minimum of them do not use the internet at all when preparing for the class.

More than a half of children learn through the internet and at the same time they consider it important, not to say the most important fact that this way they learn things that they are not taught at school.

During the lessons of informatics subjects children use most often websites assigned by the teacher or they search particular information, whereas teachers most often ask children to search for information without providing children with a specific website or address.

The vast majority of children consider social networks as a very important part of using the internet for their everyday work. More than a fifth of children use social networks also in the class and only a sixth of children use social networks neither for their personal use nor to prepare for their lessons at all.

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