MODERNIZATION OF THE EDUCATIONAL CONTENT OF IT SUBJECTS: WHAT IS, IN FACT, THE LEVEL OF KNOWLEDGE AND INTEREST IN IT-ORIENTED TOPICS IN PRIMARY SCHOOL PUPILS?

[a]MILAN KLEMENT

Palacký University of Olomouc, Faculty of Education, Žižkovo nám. č. 5, Olomouc, 771 40, Czech Republic
email: [a]milan.klement@upol.cz

Abstract: Modernization of the educational content in the field of Computer science, or IT subjects, in the conditions of Czech primary schools is a relatively widely discussed topic today, as the educational content as well as the teaching methods of IT subjects at primary schools often remain more or less unchanged for many years. However, a completely different situation can be observed abroad, where, for many years, prominent experts have been making proposals to change the concept of teaching so that pupils are not only educated to become active technology users, but are also encouraged to try to devise their own procedures, propose tools for solving specific problems and develop the so-called computational thinking. So, what does the specific educational content of IT subjects at the 1st and 2nd stage of Czech primary schools look like? Which IT topics are actually taught? Are there any topics in teaching that are not embedded or accentuated in the curriculum documents? We will try to answer these questions in the submitted paper, which presents some partial outputs of the conducted research focused primarily on the issue of the acceptance of educational content of IT subjects taught at primary schools.

Keywords: Information technology, IT reated school subjects, Educational content, Modernization of the educational content.

1 Introduction

The need for innovation of the educational content in the field of Computer science, or IT subjects, in the conditions of Czech primary and secondary schools is a relatively widely discussed topic today. However, the curriculum of IT subjects in the Czech Republic itself is still resisting more significant changes. The educational content as well as the teaching methods of IT subjects at primary schools have remained more or less unchanged for many years. However, a completely different situation can be observed abroad, where, for many years, prominent experts have been making proposals through various summits, organizations and federations (WSIS, ACM, IFIP, UNESCO)[1] o change the concept of teaching so that pupils are not only educated to become active users of technologies and their software tools, or digital content "consumers", but are also encouraged to try to devise their own procedures, propose tools for solving specific problems and develop the so-called computational thinking.

In connection with these efforts, the concept of computational thinking has emerged. This is a relatively new concept (Wing, 2006; Ribeiro, Nunes, Kniphoff Da Cruz & De Souza Matos, E, 2013; Ying, Yu & Pan, 2015), which reflects the need to understand the world around us from a new perspective, i.e. from the point of view of information and ways in which digital technologies work. It is a way of thinking that uses IT methods of problem solving, even for complex or vaguely defined problems. It develops the ability to analyse and synthesize, generalize, find appropriate problem solving strategies and validate them in practice. Furthermore, it leads to the precise expression of ideas and procedures and their recording in formal registrations, which serve as a general means of communication. It works with basic universal concepts that go beyond current technologies: algorithm, structures, representation of information, efficiency, modelling, information systems, principles of digital technology operation (see Strategy of digital learning up to 2020[2]).

All these facts imply the need for the integration of digital technologies and the development of digital competencies, in conjunction with the development of critical and creative thinking, which builds on the ability of active problem solving, computational thinking and creativity into the educational content and learning (Štípek et al., 2015; Ala-Mutka, Punie & Redecker, 2008). The need for this integration has long been emphasized in strategic, conceptual or curricular documents and is also considered to be one of the priorities of the learning strategies in developed countries (European Commission, 2013). The development of digital competences at all levels of schools, or in the context of further education, should be directed to the target entity of this educational action, which is the corresponding level of digital literacy (Štípek et al., 2015). The contemporary concept of digital competences is based on their understanding as the abilities to use relevant knowledge and skills with responsibility, autonomy, criticism and in a creative way (Ferrari, 2013). The basic framework of digital literacy, which includes not only technical skills, but also relevant knowledge and attitudes, includes seven areas of sub-competencies (Ala-Mutka, 2011):

- information management – to identify, locate, retrieve, store and organize information,
- collaboration – to connect with others, participate in online networks and communities, communicate constructively,
- communication and sharing – to communicate through on-line tools, taking into account security aspects and privacy,
- content and knowledge creation – to integrate and rework previous knowledge and content, build new knowledge,
- ethics and responsibility – to behave ethically and responsibly, be aware of legal frameworks,
- evaluation and problem solving – to identify digital needs, solve problems using digital resources, evaluate acquired information,
- technical activities – to use technologies and media, perform tasks using digital tools.

Elementary schools, as part of the formal education system, have an irreplaceable role in the targeted development of digital competencies, or the relevant cognitive and operational skills and attitudes necessary for the effective use of digital technologies. The inclusion of IT subjects as a standard component of the curriculum at primary schools—is a feature of the school systems in developed countries. However, their concepts are not consistent and the differences can be seen both in the organization, or the form of the respective educational activities, and in their scope and content (Štípek et al., 2015). A significant influence on this inconsistency can be attributed not only to different didactic approaches and levels of equipment, but also to the level of digital competences of pupils themselves. There is also a non-negligible influence of a certain "inflexibility" of the teachers of these subjects, who very often emphasize the training of specific software tools for searching and processing of text information control, rather than the targeted development of pupils' computational thinking (Rambousek, Štípek & Wildová, 2015).

There was no easy way to the outlined concept of development of pupils' digital competences—at least in terms of Czech education. Over time, the concept, content and focus of educational units focused on the development of pupils' competencies in the field of IT have been changing because of both the social demand and the development of their own technologies.

2 Analysis of the educational content of Computer science

The practical realization of the teaching of Computer science, or IT-oriented subjects, is anchored in the curriculum documents of the individual educational establishments, which are created in accordance with the 2005 school reform. This reform introduced a system of educational programs and two-stage curriculum development, which covers primary and secondary education (MŠMT [MEYS], 2017). As already stated, this system consists

[1] WSIS – World Summit on the Information Society (http://www.itu.int/wsis/index.html), ACM – Association for Computing Machinery (https://www.acm.org/), IFIP – International Federation for Information Processing (http://www.ifip.org)
[2] See http://www.vzdelavani2020.cz/images_obsah/dokumenty/strategie/digistrategie.pdf

mainly of the Framework Educational Programs (FEP) and the School Educational Programs (SEP), where the Ministry of Education, Youth and Sports of the Czech Republic (MŠMT ČR [MEYS]) issues binding Framework Educational Programs for the individual fields of education, according to which individual schools create their own School Educational Programs. The aim of this measure was to enable the graduates to be more flexible in terms of the conditions of the particular school, the needs of the regional labour market, the development of the field, the skills and interests of the pupils, and to ensure that all pupils receive comparable education corresponding to the needs of the modern labour market and the civic life (Walterová, 2004). Thus the curricular reform has given schools not only the opportunity to develop their own educational programs and take the role of an educator, but also to participate in the design of education (Tupý, 2014). The School Educational Programs are created by schools according to the FEP for the area of education they want to implement. The Framework Program is elaborated in their SEPs with respect to the pupil, the educational conditions in the given school, the needs of the regional labour market and the aims of the school's development. The SEPs are not institutionally approved, it is the director of the school who is responsible for their processing. The SEPs must be displayed at a publicly accessible place at the school.

Schools have thus been given the opportunity to adapt the content of education to the specific needs of their pupils, the specifics of their regions, as well as the specifics of the schools themselves. Within the FEP, nine educational areas, including the Information and Communication Technologies (ICT), have been defined. Within the creation of SEPs of individual schools, there was room for teaching IT topics that need not be firmly embedded within the FEP for Information and Communication Technologies, as the whole system allows relative freedom of choice of content or form of fulfilment of pupils' key competencies. This relative freedom is also given by the vague definition of the characteristics and content of the educational area of Information and Education Technologies, which specifies the expected outputs focused on what the pupil can do at the end of a given period, rather than defines a particular curriculum.

Therefore, if we want to find out what is actually being learnt at Czech primary schools within the ICT field, it is necessary to analyse in detail the SEPs of individual schools in this area. Even before the analysis, it could be presumed that individual IT topics will be probably divided into “traditional” themes (i.e. those that are firmly embedded in the FEP for the area of Information and Communication Technologies) and “non-traditional” themes (i.e. those that are expected to be embedded during the implementation of the Strategy of digital learning up to 2020).

The further presented analysis of SEP for the educational area of Information and Communication Technologies was carried out on a total of 17 primary schools located in three regions of the Czech Republic (Olomouc, Moravian-Silesian and Zlín regions). The structure of the schools was chosen to guarantee the highest informative value of the results obtained. There were small schools for 200 pupils, medium-sized schools for 200 to 500 pupils, as well as large schools for more than 500 pupils. Consideration was also given to the proportional representation of rural and urban schools, although we did not think that the equipment of rural schools could show a higher level of imperfection and incompleteness than the equipment of urban schools. However, it is necessary to admit that the availability of adequate equipment for the provision of Information and Communication Technology teaching is one of the conditions for its meaningful implementation in school education, as the ownership of these tools does not necessarily mean that they are actually used (Klement, Dostál & Bártek, 2017). Another condition for the inclusion of a given school in the analysis of its SEP in the educational field of Information and Communication Technologies was whether the school has implemented the education for both the 1st and the 2nd level of education, otherwise the results would be incomparable. Therefore, in order to be able to describe the real content of IT subjects taught at elementary schools in the educational field of Information and Communication Technologies, we carried out an analysis of the SEPs of the seventeen schools surveyed. The analysis was performed using the method of controlled structured observation of the frequency of occurrence of specific thematic units, fully with their declared content at the SEP level. The result of this analysis is presented in Figure 1.

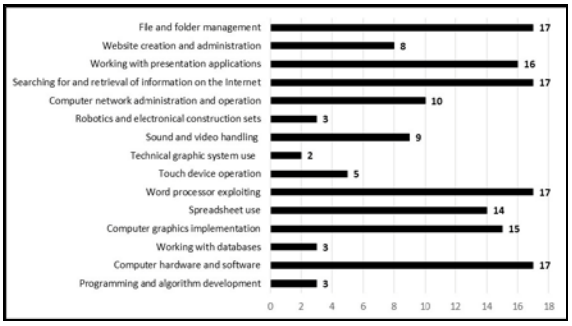

Figure 1 Frequency of occurrence of thematic units

From the above summary, it is evident that the thematic units “File and folder management”, “Searching for and retrieval of information on the Internet”, “Word processor exploiting” and “Computer hardware and software” have the highest level of representation in primary school education. These thematic units were included in all seventeen SEPs of the schools surveyed. These top-level thematic units can be supplemented with the thematic units “Working with presentation applications”, “Spreadsheet use” and “Computer Figureics implementation”, which were included in the vast majority of the schools' SEPs. This result is logical as these thematic units are firmly embedded within the framework of the FEP for the Information and Communication Technologies educational area.

Among other relatively broadly represented themes are: “Website creation and administration”, “Computer network administration and operation” and “Sound and video handling”. These thematic units were represented in the SEPs of more than 50% of the schools surveyed, which is probably the result of their optionality. Although they are not explicitly embedded in the FEP for the Information and Communication Technologies education area, some of the “traditional” thematic units affect them or provide the necessary basis for them. Also the popularity of the topics covered within these thematic units may play its part here, since the creation of videos and web presentations (e.g. the phenomenon of the so-called YouTubers) is a sought-after and appreciated skill amongst pupils today and teachers seem to reflect it in their teaching as well.

Surprisingly, the “non-traditional” thematic units “Robotics and electronical construction sets”, “Technical Figureic system use”, “Touch device operation”, “Working with databases” and, above all, “Programming and algorithm development” are not rarely represented and have higher frequencies of occurrence than would be expected. These thematic units are not mentioned in the FEP for the area of Information and Communication Technologies and their occurrence at schools is exclusively related to the will of the teachers or the school management. These are also some of the thematic units that should be developed in line with the implementation of the Strategy of digital learning up to 2020, but it is evident that teachers already feel the need for their inclusion in teaching, which is a very positive finding.

The occurrence of the thematic unit itself, although it is surprising, does not yet mean its popularity with pupils or its necessity and usefulness from teachers’ point of view. There may also be differentiated differences in the level of pupils' knowledge and skills in individual units, which may also be caused by a different approach to educational content and the issue itself. In order to understand and describe these dependencies and internal relations, it was necessary to carry out a research survey focused on the issue of the acceptance of the

teaching contents of IT subjects taught at primary schools in the Czech Republic, whose methodology, objectives and results are given in the following section.

3 The focus and methodology of the research conducted

In the previous section were described some of the developmental trends related to the development of content and forms of IT subjects teaching within the educational system of the Czech Republic as well as abroad. We also attempted to indicate some pitfalls or challenges that determine this development. However, it is not possible to determine the extent to which these trends, pitfalls or challenges are significant without examining this issue using pedagogical research methods. This examination, aimed at finding the current state of acceptance of the teaching contents of IT subjects taught at primary schools in the Czech Republic, was carried out on the basis of a research survey that took place at 35 kindergartens, primary and secondary schools during the year 2017.

This effort was based on some selected research surveys, which mapped the real situation of the teaching of IT subjects at Czech schools. From the domestic studies, we can mention, for example, the research titled *IT Competence of Children and Their Development at Primary Schools*, carried out within the project of the Grant Agency of the Czech Republic (GAČR) in 2012-2013 under the direction of V. Rambousek, which explored the attitudes of teachers and pupils towards individual themes of ICT teaching and attempted to map the state and concept of teachers' and pupils' IT competence development (Rambousek, 2013). This issue is also researched and dealt with abroad. For example, in 2012, The Royal Society published a report titled *Shutdown or restart?: The way forward for computing in UK schools*, which can be considered as one of the basic documents for defining a new English curriculum of IT subjects. Based on this document, UK specialists have decided to carry out their own project *Computing in Schools* (running from August 2010 to 2012 at selected schools in England), whose aim was to provide a sufficiently conclusive and impartial view of the current situation of the ICT curriculum in England and draw suggestions for possible changes (The Royal Society, 2012). Also in America, the issue of teaching IT topics at primary schools has been the focus of attention for several years. In particular, the Computer Science Teachers Association (CSTA) and its parent Association for Computing Machinery (ACM) have recently been actively involved in the preparation of standards for the teaching of IT subjects (or more precisely of the Computing Science) for K-12 pupils, i.e. for pupils from the first to the twelfth year of primary schools (CSTA, 2011).

The further presented research was primarily focused on *the issue of acceptance of the teaching content of IT subjects taught at primary schools in the Czech Republic* and the target group was formed by pupils of the 9th year of primary school. A part of the research was also the area of acceptance of possible changes in the educational content towards the substantial extension of the teaching of algorithmization and programming, as envisaged in the Strategy of Digital Learning up to 2020. Subsequently, the issue of digital competences and their development in the context of the contemporary concept of digital literacy with an overlap to the possibility of modernization of the educational content accepting the need for the development of pupils' digital thinking has become a subject of research activity. The subject of the research was broken down into two relatively separate research areas:

- The aim of the first research area was to find a subjective level of knowledge in IT-related topics, or teaching units, in which pupils' relevant digital competencies are being developed at primary schools.
- The aim of the other research area was to find a subjective interest in individual topics, or teaching units, that are taught in IT subjects at primary schools.

An important factor for evaluating the overall situation in the area of acceptance of the teaching content of IT subjects taught at primary schools in the Czech Republic is also the independence of the obtained results from some significant features of the respondent groups, such as their gender. Although the use of gender in the research is sometimes rightly criticized, we believe that there are some substantial reasons why this comparison should be used in this specific case. This important feature of the group of 9th year pupils could not be overlooked, as the explanation of a state that is completely dependent on gender could not be described as fully valid. For these reasons, the intention was to subject the obtained results to analyses that would verify relative independence from some important characteristics of the research sample. Thus, the following research hypotheses were formulated:

- The pupils of the 9th year of primary school – boys declare a higher level of knowledge in the IT thematic units than the pupils of the 9th year of primary school – girls.
- The pupils of the 9th year of primary school – boys declare a higher interest in the learning of thematic units that go beyond the FEP for Information and Communication Technologies than the pupils of the 9th year of primary school – girls.

A questionnaire was used as the basic means of obtaining the data needed to conduct a research survey. In the classification structure of research methods, the questionnaire is an indirect – investigative method. The questionnaire can be characterized as "a specific means by which people's opinion on individual phenomena is examined" (Chráska & Kočvarová, 2015). From the point of view of an individual (respondent), the examined phenomena can relate either to external phenomena or to internal processes. For the purposes of the research, a structured questionnaire based on the research questions and hypotheses described above (Pfitzner, Leibbrandt & Powers, 2009) was created to help determine the opinions of pupils of the 9th year of primary school about the phenomena under investigation. The questionnaire contained both closed questions with the answer offered, semi-closed questions with a range of answers (using the four-step scale), but also open questions, in which the respondents could record the varied status of the observed phenomena. To ensure the clarity of the individual questions, the questionnaire was supplemented by an explanatory text defining the terms used. The research questionnaire contained 9 questionnaire items focused on the phenomena under investigation, as well as an information apparatus that was used for the identification of some significant features of the respondents, such as the gender and age of the pupils, or the location of the school they attended. The research questionnaire was distributed, in the period from April to June 2019, among the pupils of the 9th year of a total of 35 primary schools. Altogether, the questionnaire was filled in by 342 respondents pupils of the 9th year of primary school. A detailed description of the research sample is given in Table 1.

Table 1 Structure of the research sample

Characteristic	Group	Frequency	Frequency in %
Gender	boys	144	42.1%
	girls	198	57.9%
Age	14 years	130	38.0%
	15 years	212	62.0%
Location	in the city	195	57.0%
	in the village	147	43.0%

For the determination of the power of the individual groups of respondents answering in the same way, basic descriptive statistics and their visualization with Figures were used. Furthermore, these results were subjected to an analysis, which monitored the importance of responses for individual groups of respondents broken down by significant features (such as gender). For this verification, we used the parametric Student's t-test for independent groups, which compares the averages of one variable in two groups (Chráska & Kočvarová, 2015).

The following text presents some partial outcomes of the conducted research, which was primarily focused on the issue of acceptance of the educational content of IT subjects taught at

primary schools in the Czech Republic, and whose target group was formed by pupils of the 9th year. A part of the research was also the area of acceptance of possible changes in the educational content towards the substantial extension of the teaching of algorithmization and programming.

4 The current level of knowledge in IT topics

The aim of the first research area was to find a subjective level of knowledge in IT-related topics, or teaching units, in which pupils' relevant digital competencies are being developed at primary schools. The word "subjective" is used deliberately, as the level of knowledge was assessed by the pupils themselves, which may lead to a distortion of the actual level of knowledge, since it is possible for pupils to intentionally or unintentionally reduce or increase the declared level of their knowledge. However, it should be pointed out that it was not our intention to find the current or actual level of knowledge, for which we would have to confront the declared level with the teachers' evaluation or the pupils' marks. On the contrary, we wanted to find out in which thematic units the pupils feel more proficient, and in which topics they are less competent.

Furthermore, we assumed that pupils would probably declare a higher level of knowledge in "traditional" themes, which are firmly embedded in the FEP for the area of Information and Communication Technologies. We also assumed that a lower level of knowledge would be declared in "non-traditional" themes, which are expected to be embedded during the implementation of the Strategy of digital learning up to 2020). A summary of the answers of pupils of the 9th year is given in Table 2, on the basis of which it was also possible to proceed with the verification of the established research assumption.

Table 2 Declared level of knowledge

IT thematic units	Declared level of knowledge				
	Very high	High	Low	None	No answer
Programming and algorithm development	0.0%	24.6%	45.9%	29.5%	0.0%
Computer hardware and software	0.0%	42.1%	39.8%	12.0%	6.1%
Working with databases	0.0%	23.1%	41.8%	29.5%	5.6%
Computer Figureics implementation	0.0%	56.1%	27.5%	4.4%	12.0%
Spreadsheet use	5.8%	20.8%	56.7%	0.0%	16.7%
Word processor exploiting	0.0%	43.9%	5.3%	2.6%	48.2%
Touch device operation	0.0%	28.4%	2.6%	1.2%	67.8%
Technical Figureic system use	0.0%	11.4%	48.2%	38.0%	2.3%
Sound and video handling	0.0%	27.2%	44.7%	18.1%	9.9%
Robotics and electronical construction sets	0.0%	5.3%	27.5%	66.4%	0.9%
Computer network administration and operation	0.0%	22.2%	49.4%	21.3%	7.0%
Searching for and retrieval of information on the Internet	0.0%	47.4%	3.2%	2.0%	47.4%
Working with presentation applications	0.0%	43.3%	6.7%	1.8%	48.2%
Website creation and administration	0.0%	20.8%	41.5%	33.6%	4.1%
File and folder management	0.0%	36.0%	8.5%	2.9%	52.6%

To maximize the value of the acquired data, the verbal evaluation was converted to nominal data (Maul, Irribarra & Wilson, 2016) with the following structure: answer Very high - value 4, answer High - value 3, answer Low - value 2 and answer None – value 1 (value 0 was assigned to No answer items, thanks to which we retained the original five-grade scale). This adjustment enabled us to calculate the arithmetic mean of the assessment of the declared pupils' knowledge in individual thematic units and compile a Figure of averages expressing a more accurate and more transparent mutual comparison. The whole situation is clear from Figure 2 given above.

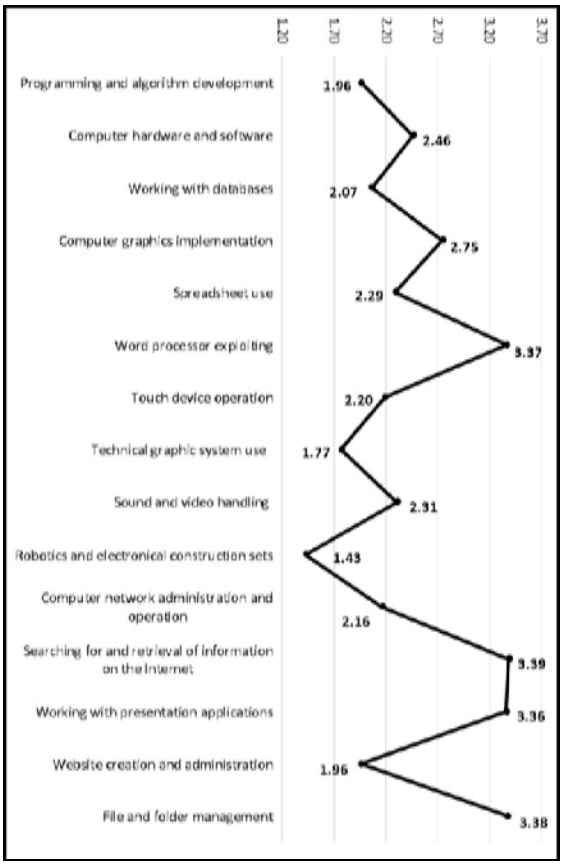

Figure 2 Declared level of knowledge - averages

From Figure 2 given above, it is clear that the highest average level of declared pupils' knowledge was reached in the thematic units: "Computer Figureics implementation", "Word processor exploiting", "Searching for and retrieval of information on the Internet", "Working with presentation applications" and "File and folder management". These are typical "traditional" thematic units that are included in the area of Information and Education Technologies, and their teaching is logically the most accented one. This, apparently, is not such a surprising result, as the fulfilment of the FEP topics, which are then reflected in the SEPs of individual schools, is thoroughly controlled within the control visits of the Czech School Inspectorate, and teachers are, therefore, forced to teach these subjects consistently. However, interesting is also the fact that "non-traditional" thematic units such as: "Programming and algorithm development", "Working with databases", "Technical Figureic system use", "Robotics and electronical construction sets" and "Website creation and administration" have reached relatively high values, too. This is explained by the fact that teachers introduce these topics into teaching within the optional content of the FEP, which is pleasing, but partly also by the fact that the pupils themselves are interested in these topics and study them independently within their out-of-school activities.

The obtained results were then subjected to further analyses, focusing on the fact whether they are not dependent on individual significant features of the respondent groups. On the basis of this, the following hypothesis (H1) was created, together with its null hypothesis ($H_{0,1}$) and alternative hypothesis ($H_{A,1}$).

H1: The pupils of the 9th year of primary school – boys declare a higher level of knowledge in the IT thematic units than the pupils of the 9th year of primary school – girls.
$H_{0,1}$: There are no differences between the level of knowledge in the IT thematic units declared by the pupils of the 9th year of primary school – boys and girls.
$H_{A,1}$: The pupils of the 9th year of primary school – girls declare a higher level of knowledge in the IT thematic units than the pupils of the 9th year of primary school – boys.

The established hypothesis was verified on a sample of 342 respondents, pupils of the 9th year of primary school, using the Student's t-test for independent groups, with the grouping variable being the gender of the respondents, as shown in Table 3.

Table 3 Declared level of knowledge versus gender

IT thematic units	Student's t-test; grouped by gender, number of respondents: 342 What is your current knowledge of, and what skills do you currently have in each of the IT topics?				
	Group 1 (girls)	Group 2 (boys)	p	Valid responses of Group 1	Valid responses of Group 2
Programming and algorithm development	1.878788	2.048611	**0.034662**	198	144
Computer hardware and software	2.207071	2.722222	**0.000001**	198	144
Working with databases	1.944444	2.187500	**0.010114**	198	144
Computer Figureics implementation	2.808081	2.687500	0.124346	198	144
Spreadsheet use	2.843434	2.840278	0.970006	198	144
Word processor exploiting	3.424242	3.312500	0.149136	198	144
Touch device operation	3.654822	3.590278	0.325846	197	144
Technical Figureic system use	1.717172	1.822695	0.176850	198	141
Sound and video handling	2.191919	2.423611	**0.015652**	198	144
Robotics and electronical construction sets	1.297980	1.555556	**0.000179**	198	144
Computer network administration and operation	2.085859	2.236111	0.100200	198	144
Searching for and retrieval of information on the Internet	3.439394	3.333333	0.141988	198	141
Working with presentation applications	3.464646	3.263889	**0.007752**	198	144
Website creation and administration	1.914141	2.006944	0.314445	198	144
File and folder management	3.419192	3.333333	0.305268	198	144

Since $p > 0.05$ is achieved only in six out of the fifteen thematic units (Programming and algorithm development $p = 0.034662$; Computer hardware and software $p = 0.000001$; Working with databases $p = 0.010114$; Sound and video handling $p = 0.015652$; Robotics and electronical construction sets $p = 0.000179$; Working with presentation applications $p = 0.007752$), we cannot reject the null hypothesis and it is therefore possible to state, with certain reservations, that *there are no differences between the level of knowledge in the IT thematic units declared by the pupils of the 9th year of primary school – boys and girls, and the obtained results are not gender-dependent.*

Again, we can point to one interesting fact, namely, that there are five "non-traditional" themes among the six partially dependent thematic units that are not covered in the FEP for the area of Information and Communication Technologies. The only "traditional" topic included among these items is "Working with presentation applications", where the girls declare a statistically significantly higher level of knowledge than the boys. For the other "non-traditional" thematic units where there is a statistically significant difference, a higher level of knowledge is declared by the boys.

For simplicity, the whole situation was again visualized in the form of a Figure depicting the arithmetic means of the assessment of the declared level of pupils' knowledge in individual thematic units, with one curve representing the girls' assessment and the other one representing the boys' assessment. The whole situation is clear from Figure 3 given below.

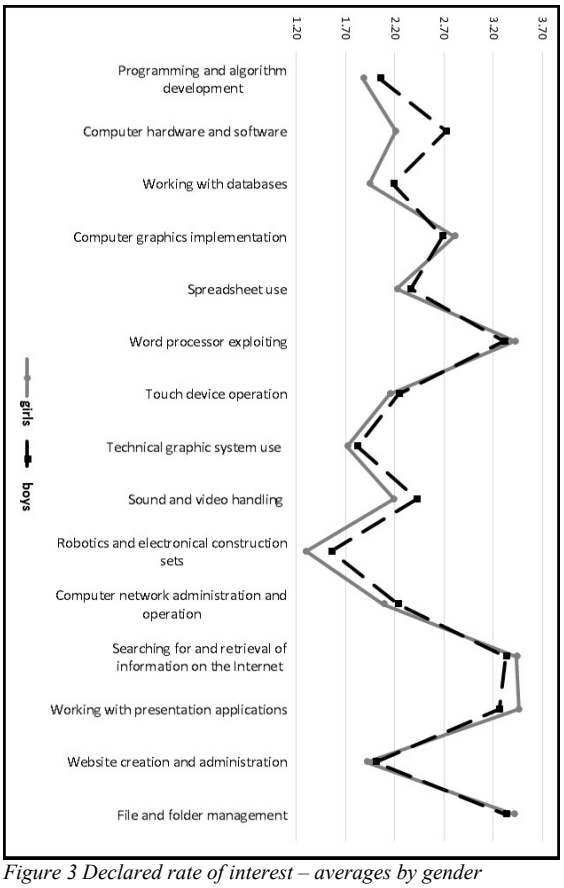

Figure 3 Declared rate of interest – averages by gender

On the basis of the performed analyses, it can be stated that the research assumption we have established was verified and refined: *The pupils of the 9th year of primary school declare that they reach the highest level of knowledge in the thematic units corresponding to the current focus of the FEP for the area of Information and Communication Technologies. The highest level of knowledge has been declared in the thematic units: "Computer Figureics implementation", "Word processor exploiting", "Searching for and retrieval of information on the Internet", "Working with presentation applications" and "File and folder management" and these results are essentially gender-independent.*

5 The rate of interest in individual IT topics

The aim of the other research area was to find the pupils' subjective interest in individual topics, or teaching units, that are taught in IT subjects at primary schools. The word "subjective" is, again, used deliberately, as the rate of interest in individual topics was declared by the pupils themselves, but the summary of their answers makes it possible to objectify this interest and identify the majority preferences of individual groups of pupils in the 9th year of primary school. The aim was to find out the actual interest rate of pupils in particular educational units focused on both "traditional" and "non-traditional" IT topics, including the comparison of this interest with the current level of knowledge presented in the previous subchapter.

Thanks to their rapid development, digital technologies are becoming more and more accessible to users, including primary school pupils. Projects, programs and multimedia records which are especially popular with pupils today, and which could have been previously created only with the use of specialized professional programs and equipment, can nowadays be created and edited using many native applications that are often part of operating systems. Their operation is also not complicated and the desired outcome can be reached in a relatively short period of time, with reasonable effort. This boom has enabled pupils to create these projects without the need for prior targeted

institutionalized training, when they are able to penetrate independently into the principles of functioning and operation of these systems and applications. It could be expected that pupils, apart from the "traditional" IT topics, might be interested also in the "non-traditional" ones, either because of their relative novelty (from their subjective point of view), or because of the above mentioned need to increasingly penetrate into the secrets of modern digital technologies. Based on this consideration, the following research assumption was established: *The pupils of the 9th year of primary school declare that they are interested in the education of thematic units that go beyond the framework of the FEP for the area of Information and Communication Technologies.*

A summary of the answers of pupils of the 9th year is given in Table 4, on the basis of which it was also possible to proceed with the verification of the established research assumption.

Table 4: Declared rate of interest in IT topics

IT thematic units	Declared level of knowledge				
	Very high	High	Low	None	No answer
Programming and algorithm development	16.7%	29.8%	40.9%	11.7%	0.9%
Computer hardware and software	14.0%	27.5%	52.3%	5.3%	0.9%
Working with databases	6.4%	21.1%	52.3%	18.4%	1.8%
Computer Figureics implementation	34.2%	37.4%	24.3%	3.2%	0.9%
Spreadsheet use	9.1%	38.3%	47.1%	4.7%	0.9%
Word processor exploiting	25.7%	45.0%	26.9%	1.5%	0.9%
Touch device operation	55.0%	30.4%	11.4%	1.5%	1.8%
Technical Figureic system use	27.2%	31.6%	34.2%	5.3%	1.8%
Sound and video handling	31.9%	40.1%	26.0%	2.0%	0.0%
Robotics and electronical construction sets	16.4%	21.3%	38.0%	23.4%	0.9%
Computer network administration and operation	7.6%	32.5%	48.2%	10.8%	0.9%
Searching for and retrieval of information on the Internet	19.6%	48.5%	30.1%	0.9%	0.9%
Working with presentation applications	27.5%	38.0%	31.6%	2.9%	0.0%
Website creation and administration	25.4%	35.7%	28.7%	9.4%	0.9%
File and folder management	18.4%	29.8%	45.6%	4.4%	1.8%

To ensure greater simplicity and visual clarity, the acquired data were also converted into Figure 4, which is given below.

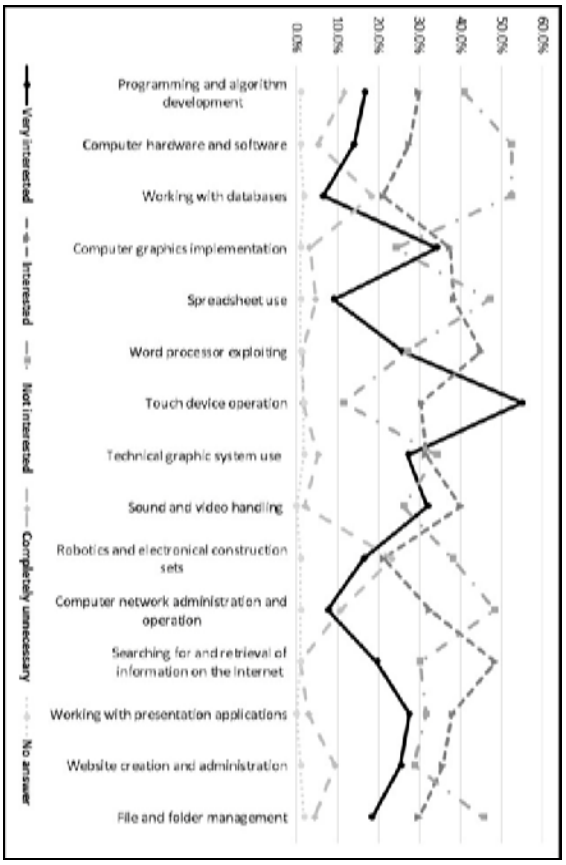

Figure 4 Declared rate of interest in IT topics - visualization

As can be seen from Table 4 and Figure 4, the highest cumulative rate of declared interest (answers: Very interested and Interested) has been reached in the thematic unit of "Touch device operation" with the value of 85.4%. Other thematic units[3] could be sorted according to the same criteria as follows: "Sound and video handling" – 72.0%, "Computer Figureics implementation" – 71.6%, "Word processor exploiting" – 70.7% and "Searching for and retrieval of information on the Internet" – 68.1%.

With regard to the results presented above, it is very interesting to note that the thematic unit of "Touch device operation" was from the point of view of the pupils who declared a very high level of interest in this topic rated the best (answer Very interested) at 55.0%. For the sake of completeness, it should be noted that this thematic unit, when evaluating the subjective level of pupils' knowledge, has reached the highest level of ambivalent assessment (No Answer) of 67.8%. This phenomenon can be explained mainly by the fact that pupils may be able to use these devices, but, within the framework of institutionalized teaching, they normally do not encounter this thematic unit, which can be considered as the cause of the above mentioned ambivalence. This explanation is also confirmed by the result given above when this thematic unit clearly showed the highest level of interest among the pupils of the 9th year of primary school. From the opposite point of view, the lowest cumulative rate of declared interest (answers: Not interested and Completely unnecessary) has been reached in the thematic unit of "Working with databases" with the value of 70.7%. Other thematic units, now in the opposite order, could be sorted according to the same criteria as follows: "Robotics and electronical construction sets" – 61.4%, "Computer network administration and operation" – 59.0%, "Computer hardware and software" – 57.6% and "Programming and algorithm development" – 52.6%. Here again, we can draw attention to one interesting fact regarding the evaluation of individual thematic

[3] Presented here is the top five topics with the highest declared rate of interest, together with the last five thematic units with the lowest declared rate of interest.

units from the indecision of interest point of view (No answer). The variance of this response reached the highest value of 1.8% for a total of four thematic units, 0.9% for a total of nine thematic units and 0.0% only for two thematic units. This result points to the fact that pupils are better able to express their interest in individual thematic units rather than subjectively assess the level of their knowledge, when we would rather expect a significant overestimation of this level.

To maximize the value of the acquired data, the verbal evaluation was, again, converted to nominal data (Maul, Irribarra & Wilson, 2016) with the following structure: answer Very interested - value 4, answer Interested - value 3, answer Not interested - value 2 and answer Completely unnecessary - value 1 (value 0 was assigned to No answer items, thanks to which we retained the original five-grade scale). This adjustment enabled us to calculate the arithmetic mean of the assessment of the pupils' declared rate of interest in individual thematic units and compile a Figure of averages expressing a more accurate and more transparent mutual comparison. The whole situation is clear from Figure 5 given below.

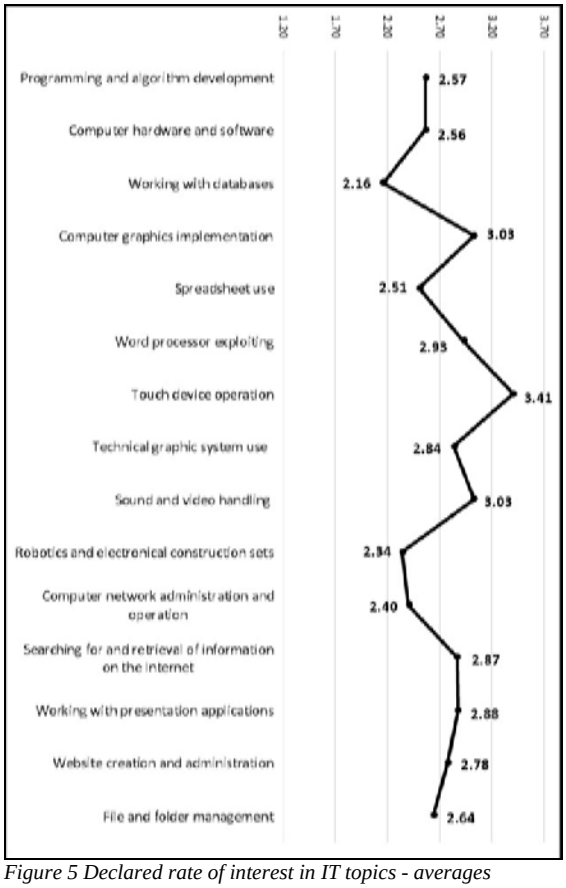

Figure 5 Declared rate of interest in IT topics - averages

From Figure 5 given above, it is clear that the highest average rate of declared pupils' interest was reached in the thematic units: "Touch device operation", "Computer Figureics implementation", "Sound and video handling", "Working with presentation applications" and "Searching for and retrieval of information on the Internet". These are not always typical "traditional" thematic units that are included in the FEP for the area of Information and Communication Technologies, but there are also topics that are not part of it. This, again, confirms the pupils' interest in other "non-traditional" thematic units, such as: "Programming and algorithm development", "Technical Figureic system use" and "Website creation and administration", which have reached relatively high values, too. The whole situation is clear from Figure 6 given below, which visualizes the comparison between the declared subjective level of pupils' knowledge and the declared pupils' interest in individual thematic units.

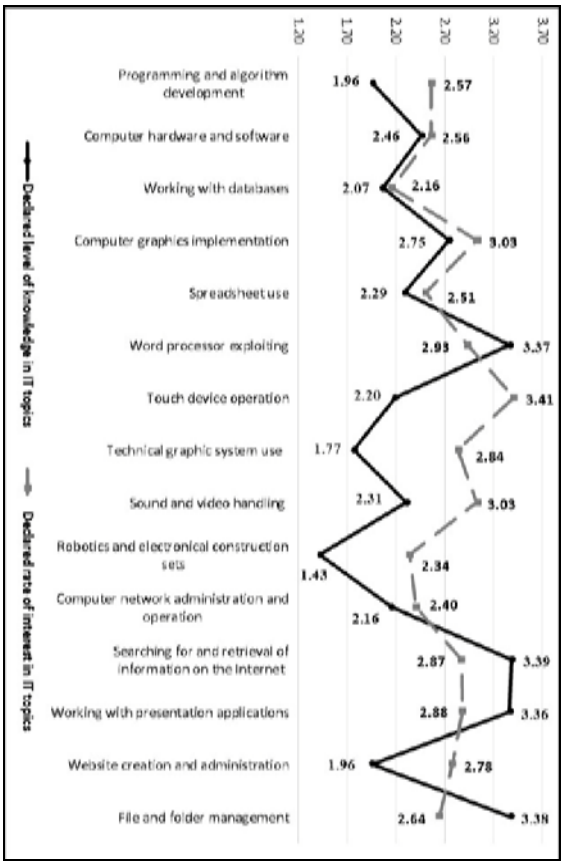

Figure 6 Declared rate of interest versus Declared level of knowledge

If we compare the individual sub-values presented in Figure 6, the greatest difference between the declared interest and the declared level of knowledge of the pupils, in favour of the expressed interest, can be seen in the thematic units of "Programming and algorithm development", "Touch device operation", "Technical Figureic system use", "Sound and video handling", "Robotics and electronical construction sets" and "Website creation and administration". These thematic units although the pupils declared a relatively low level of knowledge in them are interesting from their point of view, and they would like to be educated in them. It is also necessary to add that these are, in large part, "non-traditional" topics which are not part of the FEP for the area of Information and Communication Technologies. If we look at the issue from the opposite point of view, i.e. from the point of view of the declared level of knowledge and the declared interest, we will find out that the greatest difference can be noted in the thematic units of "Word processor exploiting", "Searching for and retrieval of information on the Internet", "Working with presentation applications" and "File and folder management", which are typical "traditional" thematic units firmly embedded in the FEP for the area of Information and Education Technologies. Although the pupils declare a relatively high level of knowledge in these areas, they are not as much interested in these topics, as they are in "non-traditional" themes.

The obtained results were then, again, subjected to further analyses, focusing on the fact whether they are not dependent on individual significant features of the respondent groups. On the basis of this, the following hypothesis (H2) was created, together with its null hypothesis ($H_{0,2}$) and alternative hypothesis ($H_{A,2}$).

H2: The pupils of the 9th year of primary school – boys declare a higher rate of interest in the education of thematic units that go beyond the framework of the FEP for the area of Information and Communication Technologies than the pupils of the 9th year of primary school – girls.

$H_{0,2}$: There are no differences between the rate of interest in the education of thematic units that go beyond the framework of the FEP for the area of Information and Communication Technologies declared by the pupils of the 9th year of primary school – boys and girls.
$H_{A,2}$: The pupils of the 9th year of primary school – girls declare a higher rate of interest in the education of thematic units that go beyond the framework of the FEP for the area of Information and Communication Technologies than the pupils of the 9th year of primary school – boys.

The established hypothesis was verified on a sample of 342 respondents, pupils of the 9th year of primary school, using the Student's t-test for independent groups, with the grouping variable being the gender of the respondents, as shown in Table 5.

Table 5 Declared rate of interest versus gender

IT thematic units	Student's t-test; grouped by gender, number of respondents: 342 Which IT topics, including those you have not come across yet, would you be most interested in?				
	Group 1 (girls)	Group 2 (boys)	p	Valid responses of Group 1	Valid responses of Group 2
Programming and algorithm development	2.256410	2.875000	**0.000001**	195	144
Computer hardware and software	2.189744	2.937500	**0.000045**	195	144
Working with databases	2.143590	2.177305	0.703790	195	141
Computer Figureics implementation	3.071795	2.986111	0.359059	195	144
Spreadsheet use	2.605128	2.409722	0.114201	195	144
Word processor exploiting	3.102564	2.763889	**0.000051**	195	144
Touch device operation	3.463542	3.347222	0.160960	192	144
Technical Figureic system use	2.743590	2.929078	0.062144	195	141
Sound and video handling	2.949495	3.111111	0.069764	198	144
Robotics and electronical construction sets	2.128205	2.555556	**0.000101**	195	144
Computer network administration and operation	2.194872	2.611111	**0.000001**	195	144
Searching for and retrieval of information on the Internet	2.923077	2.812500	0.164404	195	144
Working with presentation applications	3.020202	2.736111	**0.001832**	198	144
Website creation and administration	2.774359	2.784722	0.919951	195	144
File and folder management	2.583333	2.701389	0.200507	192	144

Since p > 0.05 is, again, achieved only in six out of the fifteen thematic units (Programming and algorithm development p = 0. 000001; Computer hardware and software p = 0.000045; Word processor exploiting p = 0.000051; Robotics and electronical construction sets p = 0.000101; Computer network administration and operation p = 0.000001; Working with presentation applications p = 0.001832), we cannot reject the null hypothesis and it is therefore possible to state, with certain reservations, that *there are no differences between the rate of interest in the education of thematic units that go beyond the framework of the FEP for the area of Information and Communication Technologies declared by the pupils of the 9th year of primary school – boys and girls.*

For simplicity, the whole situation was again visualized in the form of a Figure depicting the arithmetic means of the assessment of the declared level of pupils' knowledge in individual thematic units, with one curve representing the girls' assessment and the other one representing the boys' assessment. The whole situation is clear from Figure 7 given below.

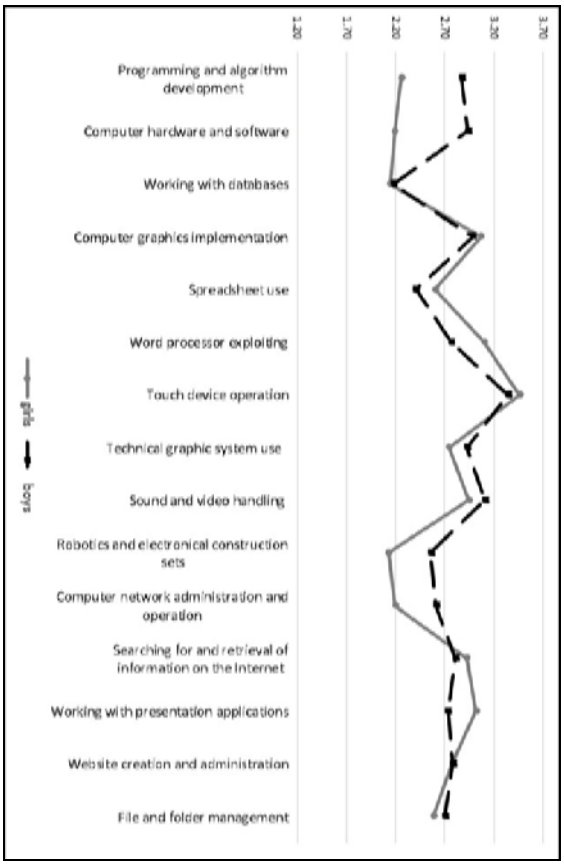

Figure 7 Declared rate of interest – averages by gender

According to the visualization shown in Figure 7, it is possible to point to one interesting fact, namely, that there are three "non-traditional" themes among the six partially dependent thematic units that are not covered in the FEP and three "traditional" ones. In the "non-traditional" thematic units of "Programming and algorithm development", "Robotics and electronical construction sets" and "Computer network administration and operation", the boys show a statistically significantly higher rate of interest than the girls. If we add to this one of the "traditional" themes: "Computer hardware and software ", where the boys declare statically significantly higher rate of interest than the girls, we can say that this analysis confirmed the generally lower rate of interest of girls in purely technical or technological themes. On the other hand, in the area of "traditional" themes, i.e. in the thematic units of "Word processor exploiting" and "Working with presentation applications", the girls show a statistically significantly higher rate of interest than the boys, which only confirms the above assumption.

On the basis of the performed analyses, it can be stated that the research assumption we have established was verified and refined: *The pupils of the 9th year of primary school declare that they are interested in the education of thematic units that go beyond the framework of the FEP for the area of Information and Communication Technologies. The highest rate of interest has been declared in the thematic units: "Touch device operation", "Computer Figureics implementation", "Sound and video handling", "Working with presentation applications" and "Searching for and retrieval of information on the Internet" and these results are essentially gender-independent.*

6 Conclusion

As stated in the introduction of this paper, the basic goal of the conducted research was to *identify and describe the current state, structure, level, concept and interest in the further development of digital competences from the point of view of pupils of the 9th year of primary school using relevant research methods*. In fulfilling this objective, it was necessary to make *a*

full explanation of pupils' opinions about individual thematic units taught within IT courses, with an overlap to finding out their preferences and interests in teaching the thematic unit of programming and algorithm development. It was, therefore, necessary to implement several steps to achieve the partial objectives for the individual parts of the conducted research. On the basis of these results, it can be stated that the established research assumptions and hypotheses have been largely confirmed and it is therefore possible to state the following: *the pupils of the 9th year of primary school declare that they reach the highest level of knowledge in the thematic units corresponding to the current focus of the FEP for the area of Information and Communication Technologies, but they are also interested in the education of thematic units that go beyond the framework of the FEP for the given area.*

The pupils understand the need for and benefits of teaching IT topics, even beyond the framework of the FEP for the area of Information and Communication Technologies. Most pupils also understand the need for teaching a thematic unit focused on programming and algorithm development, and only a minority of them does not perceive this need. The reasons leading pupils to the refusal of inclusion of algorithmization and programming in the school curriculum may vary from pure ignorance, through internal barriers, to negative experience, but it is, of course, possible to speculate about other reasons and limitations, too. It is, therefore, the task of further scientific and field work to analyse these obstacles and find ways to overcome them, so that even this part of the pupils understands the added value of this thematic unit. Furthermore, it is necessary to make further efforts in the field of research, project and field work, and try to create a concept of teaching this thematic unit not only at the appropriate depth, but also with an overlap to the practical application from the viewpoint of pupils.

7 Discussion and interpretation of the result

The obtained result is not so surprising, as the fulfilment of the FEP topics, which are then reflected in the SEPs of individual schools, is thoroughly controlled within the control visits of the Czech School Inspectorate, and teachers are, therefore, forced to teach these subjects consistently. This is also probably the reason why pupils declare a higher level of knowledge in these "traditional" thematic units than in the other ones. Here again, we must point out that the level of knowledge was assessed subjectively by the pupils themselves, which may have led to a distortion of the actual level of knowledge, since it is possible for pupils to intentionally or unintentionally reduce or increase the declared level of their knowledge.

However, interesting is also the fact that "non-traditional" thematic units such as: "Programming and algorithm development", "Working with databases", "Technical Figureic system use", "Robotics and electronical construction sets" and "Website creation and administration" have reached relatively high values, too. This is explained by the fact that teachers introduce these topics into teaching within the optional content of the FEP, which is pleasing, but partly also by the fact that the pupils themselves are interested in these topics and study them independently within their out-of-school activities. The need for lifelong learning is nowadays a necessity, and it is gratifying that pupils although in the area that is close to them (e.g. the concept of digital natives, Prensky, 2009, etc.) are already aware of this fact at such a relatively young age. Although this claim can be considered a pure speculation that cannot be based on any relevant data, we are convinced that this idea has a real basis. It is based primarily on the personal experience of almost every teenager's parents, who will surely confirm the speed at which their children are able to penetrate into new technologies and use new devices, when they are really interested in them and want to present themselves to their friends, even within social networks (e.g. the phenomenon of the so-called YouTubers, etc.).

If we realize that the development of digital technologies is very fast, and its goal is also to bring these technologies closer to the users, the obtained results will not be surprising at all. Projects, programs and multimedia records which are especially popular with pupils today (the phenomenon of the so-called YouTubers, etc.), and which could have been previously created only with the use of specialized professional programs and equipment, can nowadays be created and edited using many native applications that are often part of operating systems. Their operation is also not complicated and the desired outcome can be reached in a relatively short period of time, with reasonable effort. The pupils unconsciously feel the need to deepen these topics further within their school education, combining thus the content of school preparation with their personal life or interests. However, the question is whether these efforts do not interfere with some of the unfavourable phenomena related to social networking and the Internet (e.g. Kopecký, 2015). It could be expected that pupils, apart from the "traditional" IT topics, might be interested also in the "non-traditional" ones, either because of their relative novelty (from their subjective point of view), or because of the above mentioned need to increasingly penetrate into the secrets of modern digital technologies.

However, interesting is also the fact that, if we compare the obtained results, the greatest difference between the declared interest and the declared level of knowledge of the pupils, in favour of the expressed interest, can be seen in the thematic units of "Programming and algorithm development", "Touch device operation", "Technical Figureic system use", "Sound and video handling", "Robotics and electronical construction sets" and "Website creation and administration". These thematic units although the pupils declared a relatively low level of knowledge in them are interesting from their point of view, and they would like to be educated in them.

Literature:

1. Ala-Mutka, K.: *Mapping digital competence: towards a conceptual understanding*. Luxembourg: Publications Office of the European Union. 2011. Avaible from: http://ftp.jrc.es/EURdoc/JRC67075_TN.pdf
2. CSTA.: *K–12 Computer Science Standards*. [online]. 2011. Avaible from: http://www.csta.acm.org/Curriculum/sub/CurrFiles/CSTA_K-12_CSS.pdf
3. European Commission.: *Opening up education: Innovative teaching and learning for all through new technologies and open educational resources*. Brussels: Commision of Europian Communities. 2013. Avaible from: http://ec.europa.eu/education/news/doc/openingcom_en.pdf
4. Ferrari, A.: *DigComp: A framework for developing and understanding digital competence in Europe*. Luxemburg: Europion Commition. 2013. Avaible from: http://ftp.jrc.es/EURdoc/JRC83167.pdf
5. Chráska, M., Kočvarová, I.: *Kvantitativní metody sběru dat v pedagogických výzkumech*. Zlín: Univerzita Tomáše Bati ve Zlíně, Fakulta humanitních studií. 2015. 132 p.
6. Klement, M., Dostál, J., Bártek, K.: *Perception and Possibilities of ICT Tools in the Education from the Teachers' Perspective*. Olomouc – EU: Palacký University. 2017. Doi: 10.5507/pdf.17.24450933, 241 p.
7. Maul, A., Irribarra, D.T., Wilson, M.: On the philosophical foundations of psychological measurement. *Measurement* 79, 2016. pp. 311-320.
8. MŠMT.: *Strategie vzdělávací politiky České republiky ro roku 2020*. 2014a. Avaible from: http://www.msmt.cz/file/34429_1_1
9. MŠMT.: *Strategie digitálního vzdělávání do roku 2020*. 2014b. Avaible from: http://www.msmt.cz/vzdelavani/skolstvi-v-cr/strategie-digitalniho-vzdelavani-do-roku-2020
10. MŠMT.: *Rámcový vzdělávací program pro základní vzdělávání.* Praha. 2017. Avaible from: http://www.msmt.cz/file/43792_1_1/ RVP ZV_2017_červen.pdf
11. Pfitzner, D., Leibbrandt, R., Powers, D.: Characterization and evaluation of similarity measures for pairs of clusterings. *Knowledge and Information Systems.* Springer. 19 (1). 2009. pp. 361–394.
12. Prensky, M.: Homo Sapiens Digital: From Digital Immigrants and Digital Natives to Digital Wisdom. *Innovate* 5(3). 2009. Avaible from: http://www.innovateonline.info/pdf

/vol5_issue3/H._Sapiens_Digital_From_Digital_Immigrants_and_Digital_Natives_to_Digital_Wisdom.pdf
13. Rada Evropské Unie.: *Závěry rady o úloze vzdělávání a odborné přípravy při provádění strategie Evropa 2020*. 2011. Avaible from: http://bit.ly/1p4qF8U
14. Rambousek, V. et. al.: *Rozvoj informačně technologických kompetencí na základních školách.* Univerzita Karlova, Pedagogická fakulta UK, Dopravní fakulta ČVUT. Praha: České vysoké učení technické. 2013.
15. Rambousek, V., Štípek, J., Wildová, R.: ICT competencies and their development in primary and lower secondary schools in the Czech Republic. *5th ICEEPSY International Conference on Education & Educational Psychology. Procedia-Social and Behavioral Sciences*, Istanbul: Turkey. 2015. pp. 535−542.
16. Ribeiro, L., Nunes, D. J., Kniphoff D. M., De Souza, M. E.: Computational Thinking: Possibilities and Challenges. *Theoretical Computer Science (WEIT) 2013 2nd Workshop-School on*. 2013. pp. 22-25.
17. Strnad, M. *Přenositelnost transformace ICT výuky na 2. stupni v Anglii do českých podmínek*. Unpublished diploma thesis. Praha: Univerzita Karlova. 2015.
18. Štípek, J., Rambousek, V., Vaňková, P. Vybrané výsledky výzkumu rozvoje digitálních kompetencí žáků na ZŠ. *Pedagogika*, 65(3), 2015. pp. 259–273.
19. The Royal Society.: *Shutdown or restart?: The way forward for computing in UK schools.* Education Section. London. 2012. Avaible from: https://royalsociety.org/~/media/education/computing-in-schools/2012-01-12-computing-in-schools.pdf
20. Tupý, J.: *Tvorba kurikulárních dokumentů v České republice: historicko-analytický pohled na přípravu kurikulárních dokumentů pro základní vzdělávání v letech 1989-2013*. Brno: Masarykova univerzita. 2014.
21. Walterová, E. et al.: *Úloha školy v rozvoji vzdělanosti, 1. a 2. díl.* Brno: Paido. 2004.
22. Wing, J. M.: Computational thinking. *Commun. ACM* 49, 2006. pp. 33–35.
23. Ying, L., Yu, L., Pan, S.: Teaching research and practice of blended leaning model based on computational thinking. *Frontiers in Education Conference (FIE). IEEE*, 2015. pp. 1-8.

Primary Paper Section: A

Secondary Paper Section: AM