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Comparison of Digital Skills Upgrading of Students and Teachers in the Digital Transformation of East-Central Europe

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Abstract

In 2023, the twelfth cycle of monitoring knowledge and digital skills in various IT areas was held under the name IT Fitness Test. Pupils/students of primary, secondary and university schools and their teachers tested their skills not only in Slovakia, but also in the neighbouring Czech Republic, Hungary, Poland and Ukraine. The aim of the IT Fitness Test is to objectively test and evaluate the digital skills of the respondents that are expected of them at the next level of study or in their professional as well as civilian life. In this way, respondents are motivated to actively deepen their practical IT skills, which they will be able to apply practically not only today, but especially in the future. Almost 150 thousand respondents in five countries tested their knowledge and digital skills. There was considerable divergence in success rates between the IT areas tested from a country perspective. Students excelled in working with the Internet but performed less well in critical thinking and complex problem solving. The results from the testing presented teachers with a relevant picture of their current level of digital skills. However, it is not possible to draw firm conclusions from the results, as they also reflect the determinants that could influence these changes to a greater or lesser extent.

Keywords: Digital skills, pedagogical innovation, pupil/student, teacher, East-Central Europe, testing, education

1. Introduction

Quality education is the foundation of any successful society and modern state and is the starting point for the future prosperity of a country. The current era inevitably requires ever higher digital literacy for people of all ages. As this trend will only increase in view of the current global

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development of society, it is important continuously to improve educational processes, especially in connection with the effective application of digital technologies and, above all, to adapt them to the current requirements of the digital age (Imran, Almusharraf, 2024). We agree with Jurinova's (2023) opinion that one of the key determinants of the success of the process of digital transformation of traditional education into modern education for the 21st century is the achievement of an appropriate level of digital skills of both pupils/students and their teachers as the main participants of the educational process.

The Member States of the European Union (EU) have the possibility to participate in various international or national studies monitoring the current level of knowledge and digital skills of their primary and secondary school pupils/students and their teachers on a regular basis (OECD, 2020). Examples include ICILS – *The International Computer and Information Literacy Study, PIAAC – Programme for the International Assessment of Adult Competencies, TALIS – The Teaching and Learning International Survey or* the IT Fitness Test project, as the largest free digital skills test in the V4 countries. The findings provide pupils/students with objective feedback on how prepared they are for their further studies at higher education level or for their professional life in the era of digital technologies. As a result, such measurements can also have a positive impact on education providers because they show them a clear vision towards quality improvement in the education system.

At this point we consider it necessary to note that the paper is a follow-up to an article published in European Journal of Contemporary Education (Záhorec, Kuruc, 2023). The current paper discusses results from the testing conducted within the twelfth cycle of the test based on their comparison with the results achieved in the previous year by the individual groups of solvers not only with respect to the required IT thematic areas but also with respect to the nationalities of the solvers.

Theoretical framework

The global trend of digital *transformation* of education has also become a priority for the Ministry of Education, Research, Development and Youth of the Slovak *Republic* (MERD&Y), which has been intensively supporting implementation of digital technologies in the education system through various national projects and initiatives for some time. The National Project *Digital Transformation of Education and Schools* (DiTEdu) can be characterized as the driving force and conceptual platform for building a sustainable system supporting digital transformation of education in Slovakia. DiTEdu's intention is to reflect to the dynamic changes that the digital era is bringing to society. In this meaning, the national project is based on the strategic document of the MERD&Y *Programme of the Informatisation of the Education until 2030*. One of the pillars within the DiTEdu project is to build a sustainable system of support for schools and teachers on the path to digital excellence, in which professional continuous support, training and resources will be provided for educational actors in line with the latest trends in digital education (NIVAM).

Within the framework of the national project IT Academy – education for the 21st century, the Ministry of Education, Research, Development and Youth of the Slovak Republic is continuously involved in other activities for primary and secondary school teachers with the intention to support the digital transformation of education in primary and secondary schools, as well as in activities involving the general public in digital lifelong learning. The concept of these activities places a strong emphasis on raising awareness and digital skills, particularly in the areas of cyber security, virtual reality and the Internet of Things (National project...). Last but not least, attention is paid to activities supporting the transition of secondary school graduates to higher education institutions with focus on IT fields of study programs, with a view to their employment in IT sector professions in the European/national labour market (Andres, Hrmo, 2020).

In all four Visegrad Group countries (the Slovak Republic, the Czech Republic, Hungary and Poland), digital means play an important role in the reform of education systems, with an increased emphasis on supporting the development of digital skills not only of young people but of the whole society through lifelong learning (Esses et al., 2021). The continuous acquisition and development of digital skills is a prerequisite for the successful continuation of the young population in higher education or in professional careers within society (Frolová, Roháč, 2023). All four Visegrad Group countries share common challenges in the digital transformation of education, such as modernising infrastructure, improving the digital skills of pupils, students and teachers, and integrating the means of digital technologies into the classroom (Mhlanga, 2024).

We share the view of Frolova et al. (2020) that investing in teacher professional development and ensuring equity of access to technology are key to further progress. Overcoming these challenges is essential to better prepare pupils/students for the demands of the digital era.

In general, one can proclaim that without sufficient knowledge and skills in various IT areas it is currently very difficult to get a professional job. Therefore, to be successful in the labour market one has to know his own strengths and weaknesses, and knowing one´s weaknesses one has to educate himself continuously in the proper areas. One of the largest (free) digital skill testing in East-Central Europe offered to the target group of pupils and students, and teachers of primary and secondary schools is carried out within a project entitled IT Fitness Test. Through this testing teachers can gain an overview of the digital skill levels of their pupils and students, they gain information in which areas their pupils and students are well prepared, and in which they need further training to be improved. However, by means of this online tool, besides the above-mentioned target groups whoever has the opportunity to (voluntarily) test his or her knowledge and digital skills in different IT areas to get a realistic picture of their level internationally. Participation in these testing is at the discretion of each participant.

The IT Fitness Test questions are compiled annually by a Slovak team of teachers, academics and IT experts. They are practical, focusing mainly on specific skills, reading comprehension, the ability to use the acquired knowledge in practice, as well as the latest trends in the digital field. The IT Fitness Test does not copy the curriculum and does not only focus on theoretical knowledge, but also reflects the requirements of the modern, ever-changing digital age.

The IT Fitness Test is published annually on a publicly accessible portal, so anyone who has filled in the required data can take part. In 2022, thanks to the financial support of the Visegrad Grants from the International Visegrad Fund, the IT Fitness Test has been successfully extended to all V4 countries. In addition to Slovak, the test was also available in Czech, Hungarian and Polish for the first time in history, with an English version as a bonus. The largest and most comprehensive digital skills test was extended beyond the borders of the European Union in 2023. For the first time, the twelfth edition of the IT Fitness Test was also open to Ukrainian pupils and students located in Ukraine or outside of Ukraine.

2. Results and discussion

Research design

The purpose of the presented study was to answer research question RQ: *What is the position of the Slovak target group participants among the target groups of the participants from the other V4 countries (i. e. from the Czech Republic, Poland and Hungary) and Ukraine*?

Description of the research approach to the relevant research data collection

For the knowledge and competence part of the IT Fitness Test, which focuses on the actual verification of the respondent's digital skills in various IT areas, two variants of testing tools were administered.

The first variant of the test was for the age groups of the youth from 14 to 16 years. This means it was designed to test the key digital competences of pupils in the ninth grade of primary schools (which in Slovakia integrates in itself primary and lower secondary level of education) or graduates of these schools aged 14 to 16 years of age continuing their studies at a higher level of education or including already in professional life. This version of the test focuses, among other things, on students' understanding of problem-solving contexts, their ability to apply what they have learned in practice and their critical thinking skills. Tasks at different, but rather higher, cognitive levels were represented in the test.

The second test instrument is primarily intended for the target group of test takers over 15 years of age. The testing within this group involves (upper) secondary school and university students and their teachers, as well as various age categories of other interested members of the public in Slovakia. This more challenging version of the test allows verification of skills that are focused on practical basics and more advanced competences in the field of application of digital technologies in everyday life conditions. This test will give the school leaver a clear idea of whether he or she can work with computers and the Internet at the level commonly demanded by employers today. If the teacher or the school's digital technology coordinator has had the opportunity to manage the student testing process in his/her classroom/school, he/she can use the results of the testing in the educational process. Of course, the test can also help working or unemployed people of different ages to identify areas where they need to improve their IT skills.

The tasks and questions in the IT Fitness Test related to observed areas of the digital literacy come from five thematic areas (Table 2).

Two types of tasks were used in the test. Tasks with a choice of one correct answer from four answer alternatives and more complex tasks, designed as a cluster of dichotomous tasks. These tasks had several sub-questions/statements that had to be individually decided. The correct answer was the complete sequence of answers to the sub-statements, i.e., the respondent was scored if he/she answered all sub-questions correctly (i. e., chose the correct answer from a pair of choices).

Description of the processing of the collected data

Each respondent's score was continuously calculated during testing and finally converted into a percentage of success achieved in each subject area. Based on this, the respondent was classified into one of five levels – Excellent level of IT knowledge and skills (percentage success rate 100 % – 95 %); Above average level of IT knowledge and skills (94 % – 81 %); Average to above average level of basic IT knowledge and skills (80 % – 51 %); Lower to average level of basic IT knowledge and skills (50 – 21 %); Low level of basic IT knowledge and skills (percentage success rate 20 % – 0 %). At the end of the testing, the respondent was not only informed of his/her result in the form of his/her pass percentage, but was also shown the level achieved, together with a corresponding characterizing verbal comment as a recommendation on what he/she should work on improving.

Compliance with ethical standards

Participants of the stated testing were both minors as well as adults (students and teachers). However, the informed consent for their participation in these testing was not required, even in the case of the adult participants, as participation was completely voluntary, although subject to mandatory registration. The purpose of the mandatory registration was to determine the basic characteristics of the participating individuals (e.g. gender or type of the school attended), while maintaining their anonymity (no personal data involved). Compliance with data confidentiality principles was respected throughout the entire process of data collection, storage, processing and sharing. Additionally, as it results already from the above-mentioned (testing the participants´ sufficient knowledge and skills in various IT areas as a current precondition of getting an appropriate job), research based on the given testing is guided by an effort to benefit both the individuals involved and society at whole. What means, the good of all the participants was kept as the main ethical principle of the designed research.

Test results, comparison of country results and their discussion

Nearly 150 thousand respondents in five participating countries tested their digital skills in the twelfth edition of the IT Fitness Test. It is a significant achievement that Slovak respondents performed the best among the participating countries. In both versions of the test they had a higher success rate than respondents from the Czech Republic, Hungary, Poland or Ukraine. The stated finding offers us an answer to the research question RQ: *What is the position of the Slovak target group participants among the target groups of the participants from the other V4 countries and Ukraine*?

On a positive note, the overall average pass rate of all respondents, i.e. without distinguishing by nationality, was above 50 % for both test variants. Looking at the test results from a global perspective, the overall average pass rate of respondents in the easier version of the test designed for primary schools was 54.14 %. Compared to 2022 (48.25 %), there was a slight improvement of almost 6 percentage points (5.89 %). The overall average pass rate of respondents in the harder version of the test for secondary school and university students and their teachers was 50.37 %. There was an increase of more than 6 percentage points (6.12 %) compared to 2022 (44.25 %).

In the easier version of the test for primary schools, Slovakia achieved an average pass rate of 58.17 % for 7 – 16-year-olds (55.03 % in 2022 and 39.99 % in 2021). Second place was taken by Ukraine (56.04 %), third place by the Czech Republic (53.04 %), fourth place by Hungary (52.63 %) and last place by Poland (50.84 %).

The pass rate for the primary age group 14 – 16 is 61.51 % for Slovak test takers (58.72 % in 2022 and 42.53 % in 2021), which means that it is slightly above the required interval. The success rates for Czech, Hungarian and Polish researchers are 54.96 %, 50.42 % and 49.93 % respectively.

The overall sensitivity of the easier version of the test for primary schools was around 60 % in each country. We deduce from this that the test differentiated the test sample very well into solvers with good knowledge and skills and solvers with poor knowledge and skills in the different IT areas tested. More detailed basic psychometric parameters of the IT Fitness Test 2023 achieved in its easier version are tabulated from a country perspective in Table 1.

As can be seen from Table 1, the largest number of respondents participating in the monitoring of knowledge and digital skills in various IT areas was in the Czech Republic (44,041), the second largest number of respondents tested was in Slovakia (18,186). The smallest group involved in testing was the 361 Ukrainian respondents (Table 1).

Table 1. Country results for the easy version of the test

Test for solvers aged 7 to 16 years	Czech Republic	Hungary	Poland	Slovak Republic	Ukraine
Number of test solvers aged 7 – 16 years	33 784	1 868	6 361	13 240	270
Average success rate of solvers aged 7 – 16 years	53.04 %	52.63 %	50.84 %	58.17 %	56.04 %
Average success rate of solvers aged 7 – 13	49.32 %	54.02 %	51.38 %	54.36 %	–
Average success rate of solvers aged 14 – 16	54.96 %	50.42 %	49.93 %	61.51 %	–
Sensitivity of the test	56.90 %	60.80 %	58.60 %	61.68 %	60.56 %
Average success rate of teachers	71.58 %	73.39 %	62.80 %	71.91 %	–
Test Reliability (Cronbach's alpha)	0.77	0.79	0.78	0.81	0.80

Based on the statistical data obtained, we can conclude that in Hungary and Poland the largest age group was 13-year-olds. In the Czech and Slovak Republics the largest group was 14-year-old pupils. Ukrainian researchers had the highest representation of 15-year-old pupils. Based on the success rates of pupils participating in the easier version of the test by age, it is evident that in the Czech and Slovak groups the pattern of pupils' success rates in the test by age is roughly similar, in contrast to Hungary and Poland. Interestingly, in the Hungarian and Polish groups the success rate of the oldest pupils is not higher compared to the younger age groups. However, it is possible that the misreported age of the respondent is reflected here. For the Ukrainian pupils we see more pronounced fluctuations in the success rates achieved in the different age categories, which may be due to the small number of respondents (Kučera, Jakab, 2023).

In all participating countries there was a slight male predominance. From the data published in the final report of the IT Fitness Test 2023, it can be seen that the most significant differences in the representation of males and females were between Ukrainian pupils and Polish pupils. For Slovak pupils the groups were almost equally large. However, the difference in representation between male and female is smaller (except for Ukraine) than the number of respondents who did not indicate their gender (Kučera, Jakab, 2023).

As mentioned above, the easier version of the test for primary schools was divided into five thematic categories, each category containing four test items. As shown in Table 2, the highest difference in the countries' performance in each category of the test is between Slovakia (63.7 %) and Poland (50.7 %) at 13 percentage points in the thematic area of *Collaborative tools and social networks*. Conversely, the smallest difference in country performance was achieved in the *Digital safety and computer systems* category, namely between Hungarian (51.8 %) and Ukrainian (52.8 %) solvers. Pupils from Slovakia had the highest success rates in almost all areas of testing, with only Office Tools having a higher success rate among pupils from Ukraine (52.9 %). In the *Office software tools* category, pupils from Poland had the lowest pass rate (40.4 %) compared to other countries (Table 2).

The discriminatory ability of all five IT domains of the test was about the same across countries. The largest differences in sensitivity were in the topic area *Complex tasks*. This area was the least divisive for pupils in the Czech Republic, compared to other countries, despite its good sensitivity. A detailed picture of the average percentage of success in two successive cycles (2023 *vs*. 2022) in each participating country achieved in the easier version of the test with respect to the subject area queried is tabulated in Table 2.

The highest average success rate of respondents across all five countries is achieved in the *Internet* category (Slovakia – 70.5 %, Ukraine – 67.4 %, Czech Republic – 66.7 %, Poland – 64.6 %, Hungary – 62.1 %). Looking at test results achieved in previous years, we can see that the *Internet* category tends to have the best results in the long term, and this was also the case in 2023. In 2022, exceptionally, the best results were achieved in the *Digital safety and computer systems* category

(Table 2). We dare to say that the success rate in searching for information on the Internet decreases significantly if pupils have to find the source and evaluate some information in it and decide for the truth of the statements made.

The second most successful category in the easier version of the test for primary school pupils was *Collaborative tools and social networks* (Slovakia – 63.7 %, Ukraine – 62.6 %, Hungary – 58.9 %, Czech Republic 58.4 %, Poland – 50.7 %). The exception is Poland, where the second most successful category was *Digital safety and computer systems* (54.3 %). However, despite the positive results achieved, this does not mean that pupils cannot improve in this area. Overall, pupils were able to use collaboration and sharing tools and to find information on social networks. They were also able to use tools to communicate and understand the information displayed by the tool.

The easier version of the IT Fitness Test 2023 test again revealed, as every year, large reserves in the area of working with office software tools, understanding and working with structured data and their graphical visualizations, while digital skills in this IT area are one of the basic conditions for successful assertion on the labour market. Pupils also have reserves in the use of collaborative tools in office software applications. The results table shows that the *Office software tools* category was one of the least successful categories, with the lowest average success rate across countries (Poland – 40.4 %, Czech Republic – 42.1 %, Hungary – 43.9 %, Slovakia – 49.6 %, Ukraine – 52.9 %). We believe that this topic is probably also less attractive to pupils, so we need to look for appropriate methods and contexts that will be of more interest to pupils (Kelecsényi, Páleníková, 2019).

In the *Complex tasks* category, the average success rate per country ranges from 42 – 49 %. This category contained tasks with an algorithmic character. Compared to the other categories, countries (except Slovakia) scored the second lowest in this category (Czech Republic – 42.1 %, Poland – 44.2 %, Ukraine – 44.5 %, Hungary – 46.5 %, Slovakia – 49.3 %). On the basis of the results, we can devduce that pupils in all five countries participating in the IT Fitness Test have more significant reserves in solving complex problems with algorithmic character.

Table 2. The average success rate of each country in relation to the area studied

	Average success rate of researchers in participating countries								
Thematic area / Country	Czech Republic		Hungary		Poland		Slovak Republic		Ukraine
	2023	2022	2023	2022	2023	2022	2023	2022	2023*
Internet	67 %	59 %	62 %	43 %	65 %	46 %	71 %	61 %	67 %
Digital safety and computer systems	56 %	63 %	52 %	55 %	54 %	57 %	58 %	64 %	53 %
Complex tasks	42 %	48 %	47 %	43 %	44 %	45 %	49 %	50 %	45 %
Office software tools	42 %	42 %	43 %	33 %	40 %	38 %	50 %	44 %	53 %
Collaborative tools and social networks	58 %	48 %	59 %	39 %	51 %	39 %	64 %	51 %	63 %

* In 2022, the IT Fitness Test was not administered to a group of Ukrainian respondents; for the first time, Ukrainian pupils and students located in or outside Ukraine could participate in the test only in 2023

In the implementation of the test tasks in the area of *Digital safety and computer systems*, pupils from all participating countries except Poland achieved the third best success rate (Slovakia – 57.7 %, Czech Republic – 55.8 %, Poland – 54.3 %, Ukraine – 52.8 %, Hungary – 51.8 %). From Table 2 we can see a trend of year-on-year decrease in the average success rate of the whole corpus of respondents. Therefore, the achieved result cannot be assessed as pleasing. The authors Kučera and Jakab (2023) in the final report of the IT Fitness Test 2023 state that pupils have a relatively good understanding of the IT security warnings they commonly encounter. Pupils can respond appropriately to basic IT security situations and predict system behaviour based on these. They are able to make links between basic knowledge and apply it to the solution of a less standard situation. They have gaps in recognising how to properly protect sensitive data. They are not good at evaluating whether an implemented procedure will only visually obscure a particular sensitive data or make it completely inaccessible. They may also have less understanding of the principles and context of how information is stored in a data structure.

From the testing results tabulated in Table 2, it can be detected that the difference in the year-to-year success rate of solvers (2023 *vs*. 2022) achieved in the different IT areas of the easier version of the IT Fitness Test varies from 0 (Czech Republic: *Office software tools*) to 20 (Hungary: *Collaborative tools and social networks*) percentage points. However, based on the comparison of the results of the average success rate in two consecutive testing cycles (2023 *vs*. 2022) achieved in each country with respect to the queried subject area, no firm conclusions can be drawn, as other factors are also reflected, such as the change of the sample of respondents, minor changes in the wording of the questions, which may have influenced these changes more or less significantly (Kučera, Jakab, 2022). Nevertheless, the trends remain the same and the need to continue to invest capacity in building these skills in both formal and non-formal education is confirmed.

A more challenging version of the IT Fitness Test 2023 was administered to secondary and higher education students, teachers and other employed citizens of different age categories, i.e. to solvers older than 15 years of age. This version of the IT Fitness Test was divided into five thematic areas (as in the case of the test for primary school intended for ninth graders and graduates of primary school), with each thematic area containing five tasks. In terms of the success rate of respondents in this more challenging version of the IT Fitness Test, Slovakia achieved the best average success rate (57.17 %) (as in the easier version). Compared to 2022 (52.55 %), the success rate of Slovak respondents in the test increased by almost 5 percentage points (4.62 %). In terms of the next ranking in terms of achievement, Ukraine (51.24 %), the Czech Republic (49.57 %), Hungary (47.20 %) and Poland (46.67 %) followed (Table 3). This means that the success rate in verifying the digital skills and knowledge of this group of solvers is again, as in 2022, in the range of the optimal test pass rate of 50 % – 60 %.

If we look at the results in more detail, Slovak students and teachers achieved the highest average success rate in terms of individual countries (students – 55.70 %; teachers – 64.64 %). The target group of other employed citizens of different age categories participated in the testing only in Slovakia and the Czech Republic. The test for the over 15 age group was completed by 6 699 respondents who indicated that they were teachers (4 048 teachers in 2022). Teachers from the Czech and Slovak Republics participated in the teacher testing the most (Czech Republic – 3,576 teachers, Slovak Republic – 2,540 teachers). The average age of teachers involved in the testing was 45 years in the Slovak, Czech and Hungarian groups, and 44 years in the Polish group.

The overall discriminatory power of the test was around 55 % in each country, which can be considered very good sensitivity. In Table 3, we present in more detail the basic psychometric parameters of the IT Fitness Test 2023 achieved in its more challenging variant from a country perspective. Table 3 tabulates the results, separately for the group of secondary and university students, separately for the group of teachers, and separately for the group of other employed citizens of different age categories.

Table 3. Country results for the more difficult version of the test

Test for solvers over 15 years old	Czech Republic	Hungary	Poland	Slovak Republic	Ukraine
Number of test solvers over 15 years of age	37 405	4 913	9 533	30 060	249
Average success rate of all solvers	49.57 %	47.20	46.67	57.17	51.24
Average success rate of students from secondary schools/universities	47.89 %	46.39 %	45.02 %	55.70 %	51.24 %
Average success rate of teachers	63.61 %	64.53 %	60.12 %	64.64 %	–
Average success rate of others of citizens of different age categories	62.77 %	–	–	64.39 %	–
Sensitivity of the test	54.84 %	55.24 %	57.19 %	58.73 %	56.27
Test Reliability (Cronbach's alpha)	0.80	0.80	0.82	0.84	0.82

Although the more challenging version of the IT Fitness Test was designed primarily for solvers over 15 years of age, i.e. for high school and university students, there were also younger or older age groups among the respondents. If we look at the solvers of the more challenging version of the test from a global perspective, the strongest age category consisted of respondents aged 15 – 18, corresponding to high school students. In Poland and Hungary, 15-year-old students were the

most represented, with participation decreasing with increasing age. In Slovakia and the Czech Republic, 16-year-old students had the highest representation. In the Ukrainian group, 17-year-old students were overrepresented in the more difficult version of the test administered.

Regarding the participation of respondents in the more difficult variant of the IT Fitness Test depending on gender, in the Czech and Slovak Republics men and women are almost equally represented. On the contrary, in the group of Hungarian, Polish and Ukrainian students, the representation of males is significantly higher. In the group of Hungarian students, the difference in the representation of men and women is the highest at almost 24 percentage points.

Based on the results tabulated in Table 4, we can conclude that the highest average success rate in testing respondents' digital skills depending on their nationality was achieved in four out of five countries in the *Internet* category (Slovakia – 68.84 %, Ukraine – 59.76 %, Czech Republic – 58.66 %, Poland – 55.28 %, Hungary – 53.56 %). Despite the fact that similar skills have been tested in the IT Fitness Test in Slovakia in previous years, the results do not see a significant improvement in these IT skills (2022 – 65.60 %). In Hungary, the highest average success rate was achieved by respondents in the *Collaborative tools and social networks* category (55.86 %). Students' success rate decreases when they have to compare the information they have searched for on the Internet with each other, critically evaluate it and make clear statements. Pupils also have less experience in searching for information in a specific text document.

The lowest average success rates of the respondents are in the category *Office software tools* (Hungary – 35.83 %, Poland – 36.03 %, Czech Republic – 37.15 %, Ukraine – 39.36 %, Slovakia – 42.15 %) and in the category *Complex tasks* (Poland – 39.62 %, Hungary – 41.03 %, Czech Republic – 44.36 %, Ukraine – 47.79 %, Slovakia – 52.67 %). On the other hand, we can observe a year-on-year increase in the success rate of respondents in both categories in all participating countries. This can be seen as a positive development. Despite the observed year-on-year improvement, knowledge and skills in office tools have long been weak and insufficient, e.g. for employers' requirements. Students have gaps in skills and knowledge of working in vector graphics, and they do not know how to use adequate digital tools for multi-person collaboration in office software applications. They are relatively proficient in using simple digital tools to work with tabulated data. However, they have considerable margins when applying the filtering conditions and then evaluating the tabulated data. Observations from practice during test solving show that students are willing to work their way to a more laborious and incompetent solution. They do not think about the efficiency and reliability of the solution, they do not know how to use efficient tools, they lack the ability to question the correctness of the solution method and look for a method that leads to less error. It is questionable whether they are guided to do this in the school classroom or whether the school system is just focused on getting to the result.

The thematic area *Complex tasks* included tasks focused on complex skills when working with files, tasks for searching information in an interactive graph and their subsequent evaluation, and last but not least, tasks for detecting the control and setting of a certain sequence of commands in a program notation. The *Complex Tasks* topic included tasks focused on complex skills in working with files, tasks to find information in an interactive graph and then evaluate it, and last but not least, tasks to investigate the control and setup of a certain sequence of commands in a program notation. Despite the fact that we observe a year-on-year increase in the success rate of respondents in the *Complex Tasks* topic area, we see that high school and university students completing the more difficult version of the IT Fitness Test have deficiencies in solving tasks with higher cognitive demand. We share the view of the authors of the IT Fitness Test 2023 that we still see a lot of room for improvement and refinement of respondents' skills in solving complex algorithmic tasks. We believe that to improve future testing results, tasks of this nature need to be included more frequently in the primary school curriculum.

The category *Collaborative tools, and social networks* was the second most successful category in the four participating countries (Slovakia – 65.69 %, Ukraine – 57.99 %, Hungary – 55.86 %, Czech Republic – 55.13 %, Poland – 51.34 %). The exception was the respondents from Hungary, who achieved the highest success rate in this category (55.86 %). From the table of results, it is possible to observe, for example, a year-on-year increase in the success rate of approximately 21 percentage points in the group of Hungarian respondents, and an increase in the success rate of approximately 15 and 13 percentage points in the group of Polish and Czech respondents, respectively. Based on the results achieved in the individual tasks in this area of testing, we can conclude that basic knowledge and working with cloud-based tools for collaborative

online document creation and management are also at a good level. At this point we consider it necessary to note that it was the tasks in the area of Collaborative tools and social networks that best divided the sample of tested respondents, when the sensitivity in this area reached the highest value in all participating countries (Poland – 71.28 %, Ukraine – 68.41 %, Hungary – 67.81 %, Slovakia – 66.54 %, Czech Republic – 62.66 %) (Kučera, Jakab, 2023).

The *Digital safety and computer systems* category was the third most successful category in all countries (Slovakia – 56.48 %, Czech Republic – 52.56 %, Ukraine – 51.33 %, Poland – 51.08 %, Hungary – 49.71 %). Also in this category, Slovak solvers were the most successful among all countries, but the average success rates of individual countries were more balanced among themselves. If we look at the results of the Slovak solvers retrospectively, we can see that this category has one of the highest success rates for a long time. Based on testing the same skills compared to 2022, we see a slight deterioration of 3 (Slovakia) and 2 (Czech Republic, Poland) percentage points in this category in the group of Slovak, Czech and Polish respondents, respectively. Based on the results of solving tasks from the thematic area of *Digital safety and computer systems*, we can say that students have a relatively good understanding of what security warnings mean, which they commonly encounter when working with digital information. Students are good at identifying a fraudulent message and know how to respond to it Reserves in recognising how to properly protect sensitive data. Students are less successful in situations of securing sensitive information that they have not encountered before and that are less talked about in society.

Table 4. Average achievement of each country in the more difficult version of the test in relation to the subject area queried

	Average success rate of researchers in participating countries								
Thematic area / Country	Czech Republic		Hungary		Poland		Slovak Republic		Ukraine
	2023	2022	2023	2022	2023	2022	2023	2022	2023*
Digital safety and computer systems	59 %	63 %	54 %	50 %	55 %	52 %	69 %	64 %	60 %
Complex tasks	53 %	65 %	50 %	46 %	51 %	53 %	57 %	60 %	51 %
Office software tools	44 %	42 %	41 %	31 %	40 %	34 %	53 %	44 %	48 %
Collaborative tools and social networks	37 %	36 %	36 %	25 %	36 %	26 %	42 %	33 %	39 %
Digital safety and computer systems	55 %	42 %	56 %	34 %	51 %	36 %	66 %	51 %	58 %

* In 2022, the IT Fitness Test was not administered to a group of Ukrainian respondents; for the first time, Ukrainian pupils and students located in or outside Ukraine could participate in the test only in 2023

Regarding the sensitivity of the more challenging version of the test in the IT categories, we can conclude that each of the categories differentiated the test sample very well into solvers with good knowledge and skills and solvers with poor knowledge and skills. The *Collaborative tools and social networks* category had the highest sensitivity. The lowest, if still good, sensitivity was for the *Digital safety and computer systems* for Ukrainian students (Kučera, Jakab, 2023).

The highest differences in achievement in the individual categories of the test achieved within the participating countries are at the level of 26.69 percentage points in the group of Slovak respondents between the category *Internet* (68.84 %) and *Office software tools* (42.15 %). When comparing the results between the participating countries, we see that the highest differences in achievement are recorded at the level of 15 percentage points in the *Internet* category between the Slovak (68.84 %) and the Hungarian (53.56 %) and at the level of 14 percentage points in the *Collaborative tools and social networks* category between the Slovak (65.69 %) and the Polish (51.34 %) solvers. On the contrary, the lowest differences in success rates between countries are at 0.20 percentage points between Hungarian (35.83 %) and Polish (36.03 %) researchers in the *Office software tools* category and at 0.25 percentage points between Polish (51.08 %) and Ukrainian (51.33 %) researchers in the *Digital safety and computer systems* category. A detailed percentage picture of the average success rate of two consecutive testing cycles (2023 *vs.* 2022) in

each participating country achieved in the more challenging variant of the test with respect to the queried subject area is tabulated in Table 4.

If we look at the results achieved in the more challenging version of the IT Fitness Test 2023 designed for solvers over 15 years of age, then we can proclaim that students perform well in activities they encounter more often, are better at solving tasks with lower cognitive demand, where reading comprehension and the use of critical thinking are not required. They have mastered knowledge from their schooling at a more formal and theoretical level, with little ability to link and apply it to practical situations. Many students have gaps in digital skills and competences that are not only essential for their further studies, but also in digital skills that are needed in everyday life or required by employers in the labour market.

3. Conclusion and recommendations

The differences in achievement between the assessed IT domains within countries, or between countries, are relatively large. In terms of the whole corpus of respondents, the best results were achieved by respondents in the area of working with the *Internet*. On the contrary, reserves were noted among pupils and students in working with office tools, but also in understanding how to work with structured data, in working with tabulated data and their graphical visualizations. Educational experts agree that young people should be most concerned with developing critical thinking, quantitatively evaluating information, assessing its quality, credibility or truthfulness (Lombardi et al., 2021; Ma, et al., 2023; Idil et al., 2024). We are convinced that the testing results achieved in the IT Fitness Test 2023 can help the governments of the participating countries to take effective measures that will lead to the improvement of the education system and digital skills not only of the youth but of the whole society.

The necessity of reforming the Slovak education system is also highlighted by the latest results of the international PISA measurement, which showed a significant decline in the performance of pupils. Fifteen-year-old pupils had worse results in mathematics and reading literacy. Thus, one in three pupils did not even reach the basic level when tested (OECD, 2023a; OECD, 2023b).

The long-term conceptual goal of the Slovak Ministry of Education, Research, Development and Youth was to prepare a reform of the educational content, the so-called curricular reform of the Recovery and Resilience Plan of the Slovak Republic, which focuses on meeting the needs of education for the 21st century. One of its main objectives is to prepare educational institutions in the field of regional education to implement concrete steps towards their digital transformation into schools that develop digital competences of their pupils and teachers, effectively use digital technologies in communication with the community of educational actors, in teaching and in active pupil cognition (Pupala et al., 2022). The pilot launch of the reform has already started in 40 primary schools in the school year 2023/2024, while from September 2026 all Slovak primary schools should follow the new curriculum. We firmly believe that the curriculum reform of education will gradually bring positive results in relation to the education of young people.

In this context, we share the views of education policy experts that it is not only about improving results in international measurements, but mainly about ensuring that our pupils understand the content they learn in school and are able to apply it in their future and professional life (Hall et al., 2019; Brečka et al., 2022). If we want to cope well with the digital transformation of society, high-quality digital skills are a necessity. And not only in terms of mastering new digital technologies, but also in terms of working with digital content. We believe that the IT Fitness Test takes this aspect into account. In fact, proper evaluation of content on social media, critical thinking, and the ability to distinguish between true and false information are also key to protecting the democratic values of our society.

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