THE MODERN PRACTICES OF USING INFORMATION TECHNOLOGY IN ELEMENTARY EDUCATION

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Abstract: The use of information and communication technology (ICT) is becoming more widespread and important in elementary schools around the world because ICT has the potential to facilitate learning processes and innovative approaches in teachers' practices. The article aimed to assess the current practice of information technology in elementary education, using the example of the Czech Republic and Slovakia. The research methodology was based on statistical analysis and analysis of the results of a survey of Czech and Slovak teachers on the inclusion of ICT skills development subjects in teacher training programs, the use of skills in practice, and the effectiveness of professional development of ICT skills of teachers. The results indicate that in the innovative pedagogical practices of teachers in OECD countries the introduction of technology and digital tools for teaching elementary school students is the least common type of innovation. Within OECD countries there is almost no difference in the implementation of innovative technologies in pedagogical practice. The limited availability of computers and the Internet for students was revealed. It was determined that in the Czech Republic and Slovakia, thematic disciplines related to technology were included in formal educational training programs for teachers in 45% and 63% of cases, respectively. At the same time, a high level of ICT training in both countries was assessed (in the Czech Republic 89%, in Slovakia 95%). Differences in subjective assessment of the need for professional development of ICT skills between the countries were found (43% and 60%, respectively). Among Czech and Slovak teachers who had undergone professional development for ICT skills development, more claimed positive effects such as supplementing prior knowledge, adapting to personal development needs, holistic structure, reinforcement of subject content teaching in the school by the teacher, active learning, using new ideas and knowledge in the classroom, introduction of different activities in teaching, focus on innovative teaching practices.

Keywords: information technology, elementary education, use of ICT, development, ICT skills.

1 Introduction

The use of information and communication technology (ICT) is becoming more widespread and important in elementary schools around the world because ICT has the potential to facilitate learning processes and innovate teacher practice. Among the main potential innovations, thanks to ICTs is the autonomous learning of students and their active involvement in the learning process. To successfully integrate such technology into classroom practice, we need to promote alignment between existing educational practices and the use of information and communication technologies in the classroom. Teachers play a significant role in integrating information and communication technology (ICT) in schools, and motivated teachers reflect a higher level of ICT use in the classroom.

This article aims to assess current practices in the use of information technology in elementary education using examples from the Czech Republic and Slovakia.

2 Literature review

Change and improvement are two keywords associated with innovation in general and, in particular, innovative learning using ICT. Based on these two keywords, educational innovation can be defined as "the application of an idea that stimulates planned innovative changes in educational processes, services or products and then leads to improved learning outcomes" (Vanderlinde & van Braak, 2011).

The role of the computer in educational innovation is seen as a facilitation tool because educational innovation deals with the topic of "knowledge." The ability of technology to manage information makes it an ideal tool to develop the potential of different options for implementing innovative teaching methods. The different ways in which teachers and students interact are guided by teaching methods. This means that the computer can be used to: improve existing teacher-student interaction methods, such as replacing traditional lecture lessons; disseminating alternative methods that are difficult to implement in the current environment, such as individualized instruction; developing new methods, such as flipped learning; analyzing data from teacher-student interactions to assist in decision-making to improve instruction (Sein-Echaluce, Fidalgo-Blanco & Alves, 2017).

The scholarly literature discusses 21st-century skills in the context of elementary education. The results of Chalkiadaki (2018) showed a particular interest in skills and competencies related to the conditions of information-communication technology development, globalization, and the need for innovation. Nevertheless, the need for research focusing specifically on the context of ICT use in elementary education was recognized. Research by Kırkgöz (2008a; 2008b) emphasizes the need for ongoing teacher training and teacher development opportunities, especially in the critical first few years of the innovation process to facilitate curriculum innovation in elementary education. A study by Uluyol & Şahin (2016), through a survey of 101 elementary teachers from 24 elementary schools in Turkey, assessed the current state of teachers' ICT use and their motivation to use ICT. The authors argue for the need to develop more specific incentives, support, and capacity to increase teachers' motivation to improve the level and quality of ICT use in classrooms.

A study by Vanderlinde, Aesaert & van Braak (2014) examines the experiences of schools and teachers in Belgium to identify factors in the use of ICT for learning in elementary school. Particular attention is paid to teachers' widespread use of technology. Vanderlinde, Aesaert & van Braak (2014) draw the following key findings: 14% differences in teachers' use of ICT are explained by differences between schools; professional development in ICT use and ICT-related competencies are positively related to teachers' use of technology; individual differences in teachers' ICT use competencies are explained by differences between the schools in which they work. Tezci (2009) finds that the most common types of ICT among elementary school teachers are the Internet, email, and word processing software, and teachers' attitudes toward computers and the Internet are generally positive. It was also found that their attitudes change depending on years of experience and level of knowledge.

Atman Uslu & Usluel (2019) identified influencing factors for ICT integration in elementary schools, among which: 1) school-dependent factors, namely providing access, technical support, administrative support, and professional development support for teachers; and 2) teacher-dependent factors: teacher beliefs and competencies in using ICT. The model built on the above variables, verified by structural equation modeling using data from 403 teachers, indicates that these factors explain 70% of the variance of technology integration. Selwyn & Bullon (2000) found that many elementary students frequently use ICT in school, but their access to technology outside of school is varied. The findings raise questions about the challenges of using ICT beyond accessibility in the elementary grades and the need for meaningful, regular access to technology in school for all children.

A study by Vanderlinde, Aesaert & van Braak (2015) cites different types of ICT use in elementary schools: basic use of ICT as a learning tool and as an information tool. The authors also provide a list of factors for technology use: 1) at the level of the individual teacher (e.g., teacher competencies in ICT use, ICT professional development, etc.); 2) at the level of the school organization (e.g., school perception of ICT, leadership in ICT integration, etc.) that support or hinder the use of ICT for student learning.

In traditional schools, ICTs are mostly used to augment and support standard teacher-centered learning activities. Innovative schools, by

contrast, use ICT tools to support open-ended activities with active student participation and role (Sydorenko et al, 2020). Elementary schools expected ICT to increase student motivation, improve learning outcomes, promote independent learning, and allow for differentiation of students. Within these goals, however, there are clear differences in expectations between the two types of schools (de Koster, Kuiper & Volman, 2012).

A survey of 232 elementary school teachers by Kerckaert, Vanderlinde & van Braak (2015) identified two types of ICT use in elementary education: "ICT to support basic skills and attitudes toward ICT" and "ICT to support content and individual learning needs. The first type of ICT is more frequent and related to students' assessments, teachers' perception of ICT, and the number of years of experience with ICT in school. The second type of ICT is closely related to students' assessments, teachers' perceptions of ICT, teachers' professional development of ICT skills, and teachers' attitudes towards ICT opportunities for teachers. This indicates that professional development is a critical factor in encouraging ICT use, which goes beyond basic skills training and attitudes toward ICT.

Smeets (2005) surveyed 331 upper elementary teachers and found that many teachers use several elements of a powerful learning environment in their classrooms to present tasks and facilitate active, autonomous learning. The use of ICT, in general, allows only traditional approaches to learning. Teachers who created a powerful learning environment for students were more likely to use open-ended ICT applications that would enhance the learning environment, provided there was greater access to computers for students. In addition, teachers' views on the role of ICT in active and autonomous learning, teachers' development of ICT skills, and teacher gender were the most favorable factors in the use of technology.

Surveys by Tondeur, Van Braak & Valcke (2007) among 570 respondents in a stratified sample of 53 elementary schools indicate that teachers focus predominantly on developing technical ICT skills. At the same time, the curriculum focuses on the integrated use of ICT in the learning process. This indicates that there is a gap between the proposed and implemented curriculum for ICT integration.

Thus, the literature examines the experiences of schools and teachers in the use of ICT, factors promoting the use of ICT for learning in elementary school, the most common types of ICT among elementary school teachers, factors influencing ICT integration in elementary school, the problems of ICT use for accessibility in elementary school, different types of ICT use in elementary school. At the same time, there is a lack of comprehensive research on the use and practice of ICTs in elementary education in different countries.

3 Methodology

Methods

The first part of the research conducted a statistical analysis of indicators of the use of different types of innovations in elementary schools in OECD countries in 2020, including innovative technologies, tools, and instruments. An analysis of the availability of computer equipment and the Internet in elementary schools in OECD countries in 2020 was carried out.

The second part of the study includes secondary data from The Teaching and Learning International Survey (TALIS) for 2018 for the Czech Republic and Slovakia. The survey involves teachers' assessment of working conditions, the environment in schools within the country for the understanding of the challenges, especially in the practice of information technology in elementary schools.

In the context of the study, the analysis was based on the practice of using information technology in such areas as 1) inclusion of ICT skills development and ICT usage into pre-service teacher training curricula; 2) inclusion of ICT usage subjects into formal teacher training curricula and elementary school curricula; 3) inclusion of ICT usage issues in the teacher's professional development program; 4) the positive effect of ICT usage training on teachers; 5) the need for further training in ICT usage by teachers.

Table 1 – Questionnaire and checklist for teachers about ICT use in elementary schools

Question	Answers
1. Were the following elements included in your formal education, and to what extent did you feel prepared for each element in your teaching? Please mark one choice in both part (A) and part (B) in each row. h) Use of ICT (information and communication technology) for teaching	(A) Inclusion in formal education: 1 – Yes. 2 – No (B) Preparedness: 1 – Not at all; 2 – Somehow; 3 – Well; 4 – Very well
2. Were the following subject categories included in your formal education, and do you teach them during the current school year to any pupils in this school? Please mark as many choices as appropriate in each row. g) Technology Includes orientation in technology, including information technology, computer studies, construction/surveying, electronics, graphics and design, keyboard skills, word processing, workshop technology/design technology:	1. Included in my formal education. 2. I teach it to pupils this year
3. Were any of the topics listed below included in your professional development activities during the last 12 months? Please mark one choice in each row. (e) ICT (information and communication technology) skills for teaching)	1 – Yes, 2 – No
4. Thinking of the professional development activity that had the greatest positive impact on your teaching during the last 12 months, did it have any of the following characteristics? Please mark one choice in each row. (1 – Yes, 2 – No).	a) It built on my prior knowledge. b) It adapted to my personal development needs. c) It had a coherent structure. d) It appropriately focused on content needed to teach my subjects. e) It provided opportunities for active learning. f) It provided opportunities for collaborative learning. g) It provided opportunities to practice/apply new ideas and knowledge in my own classroom. h) It provided follow-up activities. i) It took place at my school. j) It involved most colleagues from my school. k) It took place over an extended period of time (e.g., several weeks or longer). l) It focused on innovation in my teaching
5. For each of the areas listed below, please indicate the extent to which you currently need professional development. Please mark one choice in each row. (e) ICT (information and communication technology) skills for teaching	1 – No need at present; 2 – Low level of need; 3 – Moderate level of need; 4 – High level of need

Source: OECD (2019).

Table 2 shows the distribution of surveyed Czech and Slovak elementary school teachers by gender. 66.7% of the respondents are Czech Republic teachers, 33.3% are Slovakian teachers. 75.4% of the respondents were female teachers, and 24.6% were male teachers.

Table 2 – Surveyed the Czech Republic and Slovakia elementary school teachers by gender

	Frequency	%
The Czech Republic	6039	66,7
Slovak Republic	3015	33,3
Total	9054	100,0
Gender – T		
Female	6823	75,4
Male	2231	24,6
Total	9054	100,0

Source: calculated by the author based on OECD (2019).

4 Results

In the innovative pedagogical practices of teachers in OECD countries, the introduction of technology and digital tools for teaching elementary school students is the least common type of innovation, as innovative teaching methods, new knowledge, services, or products predominate (Table 3). Within OECD countries, there is virtually no difference in the adoption of innovative technologies in pedagogical practice: the standard deviation is 1.9%. The percentage of students learning in highly innovative workplaces and playing a role in introducing innovation is 28.6%; the percentage of students playing a role in introducing innovation is 32.7% with a standard deviation of 1.7%; overall, the percentage of students working in highly innovative workplaces and playing a role in introducing innovation is 15.7% in 2020.

Table 3 – Innovation in elementary education in OECD countries (mean) in 2020 by type

Innovation type	Percentage of pupils working in highly innovative workplaces, 2020		Percentage of pupils who play a role in introducing innovation, 2020		Percentage of pupils working in highly innovative workplaces and playing a role in introducing innovation, 2020	
	Mean	Standard error	Mean	Standard error	Mean	Standard error
Innovation type: Knowledge or methods	56,5	-2,5	68,5	-2,0	45,2	-2,3
Innovation type: Products or services	36,8	-2,4	42,3	-2,0	24,6	-1,8
Innovation type: Technology, tools or instruments	28,6	-1,9	32,7	-1,7	15,7	-1,3
Across three types of innovation	17,0	-1,8	23,7	-1,7	8,6	-1,2
At least one type of innovation	65,4	-2,5	73,0	-1,8	54,8	-2,1

Source: OECD (2021a).

The average percentage of pupils with computers available for use in the first year was 56-57% for math, reading, and other elementary school subjects. The percentage of pupils with Internet access in the classroom in the first year is slightly lower than 49-53%, depending on the subject of elementary school (Table 4). In the final year, the figures increase, being 56-60% and 54-58%, respectively.

Table 4 – Innovation in the availability of computers and the internet in the classroom in the 4-th grade in elementary education in OECD countries (mean) in 2020

Measure	Indicator	Initial year in percentage			Final year in percentage			Change in percentage points		
		Mathematics	Sciences	Reading	Mathematics	Sciences	Reading	Mathematics	Sciences	Reading
Mean	Percentage of pupils with computers available to use and change over time	55,909	57,142	56,525	56,605	60,065	58,335	0,696	2,923	1,810
	Percentage of pupils with Internet access in the classroom and change over time	49,158	53,156	51,157	54,291	58,069	56,180	5,133	4,913	5,023
Standard error	Percentage of pupils with computers available to use and change over time	1,061	1,059	1,060	0,959	1,061	1,010	1,430	1,499	1,464
	Percentage of pupils with Internet access in the classroom and change over time	1,111	1,071	1,091	0,946	1,060	1,003	1,459	1,507	1,483

Source: OECD (2021b).

There are virtually no differences between OECD countries in the percentage of pupils with computers available for use and with Internet access, as evidenced by a standard deviation of 1-1.1%.

Compared to Slovakia, in the Czech Republic, thematic disciplines related to technology were included in formal teacher education programs only 45% of the time (orientation in technology, including information technology, computer research, construction/geodesign, electronics, graphics and design, keyboarding skills, word processing, professional technology/design). In Slovakia, teachers claim the inclusion of technology-related disciplines 63% of the time. At the same time, among Czech teachers, 3% consider unprepared to teach the use of technology in school, 60% claim an average level of preparation, 83% claim a high level, and 89% claim a very high level. In Slovakia, the distribution of responses by the level of preparation is 7%, 64%, 91%, and 95%, respectively.

Table 5 – Combinational table: Country ID – Numeric Code * Elements in form. educ. Use of ICT for teaching * Prep. for tch. elements Use of ICT for teaching

Prep. for tch. elements Use of ICT for teaching			Elements in form. educ. Use of ICT for teaching		Elements in form. educ. Use of ICT for teaching		Total
			Yes	No	Yes, %	No, %	
Not at all	Country ID – Numeric Code	Czech Republic	66	2202	3%	97%	2268
		Slovak Republic	45	611	7%	93%	656
	Total		111	2813	4%	96%	2924
Somew hat	Country ID – Numeric Code	Czech Republic	1103	732	60%	40%	1835
		Slovak Republic	562	313	64%	36%	875
	Total		1665	1045	61%	39%	2710
Well	Country ID – Numeric Code	Czech Republic	963	195	83%	17%	1158
		Slovak Republic	793	80	91%	9%	873
	Total		1756	275	86%	14%	2031
Very well	Country ID – Numeric Code	Czech Republic	445	54	89%	11%	499
		Slovak Republic	373	21	95%	5%	394
	Total		818	75	92%	8%	893
Total	Country ID – Numeric Code	Czech Republic	2577	3183	45%	55%	5760
		Slovak Republic	1773	1025	63%	37%	2798
	Total		4350	4208	51%	49%	8558

Source: calculated by the author based on OECD (2019).

Overall, 27% of teachers in both countries were trained in technology-based education, while 74% were not trained in technology-based subjects. In the Czech Republic, the training rate was 26%, and in Slovakia, it was 28%. Among those who were trained, in the Czech Republic 64% indicated that they teach subjects for the use of technology, 36% – do not teach. In Slovakia, the figures were 54% and 46% respectively (Table 6).

Table 6 – Combinational table: Country ID – Numeric Code * Subject cat. inc. in form. educ. and train Technology * Subjects taught in current school year Technology

Subjects taught in current school year Technology			Subject cat. inc in form.educ. and train Technology		Subject cat. inc in form.educ. and train Technology		Total
			Checked (Yes)	Not checked (No)	Yes, %	No, %	
Checked (Yes)	Country ID – Numeric Code	Czech Republic	543	309	64%	36%	852
		Slovak Republic	225	194	54%	46%	419
	Total		768	503	60%	40%	1271
Not checked (No)	Country ID – Numeric Code	Czech Republic	981	4140	19%	81%	5121
		Slovak Republic	623	1934	24%	76%	2557
	Total		1604	6074	21%	79%	7678
Total	Country ID – Numeric Code	Czech Republic	1524	4449	26%	74%	5973
		Slovak Republic	848	2128	28%	72%	2976
	Total		2372	6577	27%	73%	8949

Source: calculated by the author based on OECD (2019).

In the Czech Republic, 43% of teachers claimed to include ICT skills for student learning in their professional development programs, while in Slovakia it was 60%. On the other hand, 57% of teachers in the Czech Republic and 40% of teachers in Slovakia did not include such subjects.

Table 7 – Combinational table: Country ID – Numeric Code * Areas prof.dev. ICT skills for teaching

		Areas prof.dev. ICT skills for teaching		Total	Areas prof.dev. ICT skills for teaching	
		Yes	No		Yes, %	No, %
Country ID – Numeric Code	Czech Republic	2471	3341	5812	43	57
	Slovak Republic	1647	1092	2739	60	40
Total		4118	4433	8551	48	52

Source: calculated by the author based on OECD (2019).

Among Czech and Slovak teachers who have undergone professional development to develop ICT skills, more claim positive effects such as supplementing prior knowledge, adapting to personal development needs, holistic structure, reinforcement of subject content teaching in the school by the teacher, active learning, using new ideas and knowledge in the classroom, introducing different activities into learning, focusing on innovative teaching practices.

Table 8 – Type of impact of the professional development activity that had the greatest positive impact on teaching during the last 12 months

Type of impact	Yes	No	Yes	No
a) It built on my prior knowledge.	3105	366	89%	11%
b) It adapted to my personal development needs.	2382	1078	69%	31%
c) It had a coherent structure.	2692	765	78%	22%
d) It appropriately focused on content needed to teach my subjects.	2778	684	80%	20%
e) It provided opportunities for active learning.	2719	746	78%	22%
f) It provided opportunities for collaborative learning.	1649	1799	48%	52%
g) It provided opportunities to practice/apply new ideas and knowledge in my own classroom.	2800	663	81%	19%
h) It provided follow-up activities.	2522	940	73%	27%
i) It took place at my school.	1446	2018	42%	58%
j) It involved most colleagues from my school.	1054	2410	30%	70%
k) It took place over an extended period of time (e.g., several weeks or longer).	1078	2388	31%	69%
l) It focused on innovation in my teaching	2583	877	75%	25%

Source: calculated by the author based on OECD (2019).

Figure 1 provides information about the needs of Czech and Slovak teachers for professional development of ICT skills. Overall, 52% of teachers in the Czech Republic and 61% of teachers in Slovakia reported such a need.

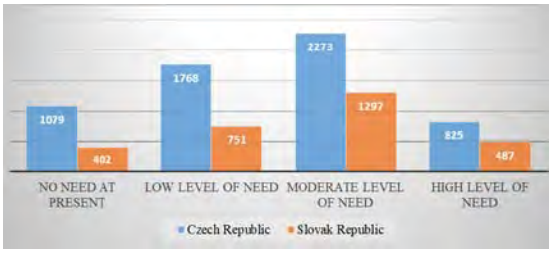

Figure 1 – Need for professional development of teacher's ICT skills in the Czech Republic and Slovakia

Source: calculated by the author based on OECD (2019).

5 Discussion

The results of this study correlate with the findings of other authors on the need for ongoing teacher training and opportunities to develop teachers' ICT skills (Kırkgöz, 2008a; 2008b). Accordingly, there is a need to develop specific incentives, support, and capacity to increase teachers' motivation to improve the level and quality of ICT use in classrooms (Uluyol & Şahin, 2016). As revealed in this work, 48% of Czech teachers and 39% of Slovak teachers do not see the need for professional development of ICT skills, which requires motivation and encouragement.

While in the study of Vanderlinde, Aesaert & van Braak (2014) we saw a widespread teachers' use of technology in the learning environment, in this one we found that only 15.7% of elementary students in the countries learn in an environment where teachers use technology. We also found differences in the level of professional preparation when teachers receive a formal education, the level of use of ICT in student learning, and the level of need for professional development of ICT skills. As shown in Vanderlinde, Aesaert & van Braak (2014) 14% of the difference in teachers' use of ICT is due to differences between schools. Additional reasons for the differences are professional development experience in the use of ICT and competencies acquired during teachers' education. It is also worth considering the individual differences of teachers, in particular competencies in ICT use, and differences between the schools in which teachers work.

This study shows no significant differentiation in the use of technology across countries in the education of elementary school students. As Atman Uslu & Usluel (2019) show, this may be due to similar school environments, particularly similar levels of access, technical support, and professional development support for teachers. Selwyn & Bullon (2000) found a difference in students' access to ICT outside of school. We also found that the adoption of technology and digital tools for teaching elementary school students is the least common type of innovation (28% and 32% of students learn in an innovative environment). This points to the problematic use of ICT for its availability in the elementary grades and the need for meaningful, regular access to technology in school for all children.

This research also confirms the effectiveness of professional development of teachers' ICT skills, is to promote active learning. These findings are contained in de Koster, Kuiper & Volman (2012). This means that ICT promotes innovative ways of teaching students, supporting open-ended activities with active student participation and role (de Koster, Kuiper & Volman, 2012).

6 Conclusion

In the innovative pedagogical practices of OECD teachers, the introduction of technology and digital tools for teaching elementary school students is the least common type of innovation. Overall, the percentage of elementary students working in highly innovative workplaces and playing a role in introducing innovation is 15.7% in 2020. Within OECD countries, there is virtually no difference in the adoption of innovative technologies in pedagogical practice.

The average percentage of pupils with computers available for use in the first year of school was 56-57%, while the percentage of pupils with Internet access in the classroom in the first year was slightly lower – 49-53%, depending on the subject of the elementary school.

In the Czech Republic and Slovakia, technology-related subjects were included in formal teacher education 45% and 63%, respectively. At the same time, among Czech teachers, 3.0% considered unprepared to teach the use of technology in school, 60% claimed an average level of preparation, 83% claimed a high level, and 89% claimed a very high level. In Slovakia, the distribution of responses by the level of preparation is 7%, 64%, 91%, and 95%, respectively. In the Czech Republic, the rate of formal ICT training was 26%, while in Slovakia it was 28%. Among those trained, in the Czech Republic, 64% said they taught disciplines to teach the use of technology, while 36% said they did not. In Slovakia, the figures were 54% and 46%, respectively. In the Czech Republic, 43% of teachers say they include ICT skills subjects in their professional development programs to teach students, compared to 60% in Slovakia. Among Czech and Slovak teachers who had undergone professional development for ICT skills development, more claimed positive effects such as supplementing prior knowledge, adapting to personal development needs, holistic structure, reinforcement of subject content in school by the teacher, active learning, using new ideas and knowledge in the classroom, introduction of different activities in teaching, focus on innovative teaching practices.

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Primary Paper Section: A

Secondary Paper Section: AM