Pedagogical Implications and Methodological Possibilities of Digital Transformation in Digital Education after the COVID-19 Epidemic

Zoltán Szűts [1,*] **, György Molnár** [2] **, Réka Racsko** [3] **, Geoffrey Vaughan** [1] **and Tünde Lengyelné Molnár** [3]

[1] Doctoral School of Education, Faculty of Pedagogy, Eszterházy Károly Catholic University, Eszterházy Square 1, 3300 Eger, Hungary

[2] Kandó Kálmán Faculty of Electrical Engineering, Óbuda University, Bécsi út 96/B, 1034 Budapest, Hungary

[3] Institute of Digital Technology, Faculty of Informatics, Eszterházy Károly Catholic University, Eszterházy Square 1, 3300 Eger, Hungary

* Correspondence: szuts.zoltan@uni-eszterhazy.hu

Abstract: In the context of digital pedagogy, internet communication platforms, digital media interfaces, applications, and info-communication tools, best practices are stepping up in the educational process and forming a methodology. The focus areas targeted by the questionnaire presented in this study are digital transformation; the smart use of digital tools; characteristics of the learning environment; classroom activities, learning organization, and methodology; content; and curriculum sharing. During the research, the authors asked what were the online communication channels and digital platforms that teachers have effectively used in terms of learning efficiency in distance learning ordered as a result of the COVID-19 emergency in Hungary. The empirical research goal was to explore the conditions among Hungarian teachers with the help of a questionnaire and a semi-structured online interview. Seven thousand teachers were contacted through email, and a return rate of 10.7% was achieved. The questionnaire was filled in online by $n = 751$ primary teachers. According to the respondents, the most effective tools in the transformation of education are self-made tutorial videos and real-time written and video-based chat.

Keywords: ICT; digital pedagogy; digital transformation; COVID-19

1. Introduction

In 2020, the coronavirus epidemic posed unprecedented challenges for the world and for education. The interpretation of this difficulty as a challenge and an opportunity for development ("COVID-19 as an opportunity") has rapidly spread in the discourse on the epidemic, motivating education stakeholders, among others, to respond immediately and effectively. A common feature of the research launched during the epidemic period is that all of it examines the consequences of the situation that has already arisen, the impact on those involved in education, and satisfaction with the solutions adopted [1]. This study takes a different approach to the problem. In the theoretical part of this paper, the authors examine how digitalization has transformed education, adopted distance learning, and to what extent has ICT permeated the universe of education. The research presented was conducted during the epidemic and enquires about the use of tools and methodology by a teachers' organization.

This study focuses on education during a crisis, but the research results can be applied in the long run. The new coronavirus (SARS-CoV-2) identified in late 2019 spread worldwide in March 2020. Governments ordered various restrictive measures to slow the spread of the infection, including school closures. Hungary opted for online education and turned to digital technologies: computers, smart devices, and networks. Thus, from 14 March 2020, the idea of digital distance learning and the digital pedagogy defining the methodological framework and its practical application gained importance in Hungary.

During this period, previously designed distance learning methods were used in line with a unified concept, highlighting the importance of digital pedagogy [2]. The epidemic-induced changes introduced during the period were in place for a short time, but several lessons were learned [3–7].

In the present work, the authors hypothesize that the changes that have taken place in the field of online communication and digital media since the appearance of Web 2.0 around 2006 have already created a new paradigm and brought about a rearrangement between the components of the educational theory and methodology system. In the context of digital pedagogy, internet communication platforms, and online media interfaces, applications, info-communication tools, and strategies are stepping up in the educational process and forming a methodology of educational tools [8].

If the necessary conditions are met, digital pedagogy can not only transform, but also make teaching and learning processes more efficient, which is the goal of all pedagogical development. Moving toward the general conclusions, the spread of info-communication technologies and social networks has also had a significant impact on the transformation of education. Forms of learning, problem-solving, decision making, and cooperation have changed. In the information society, thanks to networks, individuals go beyond their primary communities and are already more effectively informed through the variability of their relationships. The online environment allows individuals to appear and manifest independently or even as part of communities. This statement also applies to the extended classroom, so it is understandable why the importance of formal and informal group work based [9] on students' networking activity and communication is growing.

At present, with the rise in internet communication and media, education is facing a number of new challenges. The model based on the triple requirement of reading, writing, and numeracy is being replaced by the four C (collaboration, curiosity, complexity, creativity) paradigm. Benő Csapó shed [10] light on "the problems and untapped potential of school education" in connection with "models describing human thinking as information processing," and analyzed parallel human and machine information processing models. Réka Racsko formulated a critique of the current state of education when she wrote that the environment [11], culture, and constantly appearing external stimuli pose a challenge to the human nervous system. However, the education system is lagging behind, not following the transformation associated with increased information flow; the predominance of writing, reading, and counting has remained, while information acquisition, processing, storage, and sharing are already based on the nature of the network [12]. An education system must therefore represent a new natural learning environment that does not interfere with the everyday routines of an information society [13], but takes good practices from them: it teaches students to select, process, and pass on information and brings the pace of this activity closer to the pace of everyday life [14,15].

2. Materials

The Internet has now become a global communication network and information storage system for more than half of the world's population. It is a system that allows users, including teachers and students, to collaborate and interact, regardless of space and time, while increasingly spanning across cultures and boundaries.

According to András Benedek, digital pedagogy is a traditional or constructive method of pedagogy, i.e., teaching and learning. In digital pedagogy, both the teacher and the student use a computer and an IT tool. This presents both challenges and opportunities for learners and instructors in the information society [16]. The pillar of digital pedagogy, in addition to educational science, is online communication and media. For example, György Molnár proposed the following thematic classification of ICT: ICT as a tool; organizational technique; media; development and society-building process; and as a practice [16].

The central pillar of digital pedagogy is not the technology, but the user and their cognitive activity. The conscious user—the teacher and the student—recognizes system failures, takes a critical approach to resources, recognizes the connections between the

information available online and offline, and strives to apply knowledge creatively in various situations. The information society's cognitive habitus will need to include rapid processing and storage in addition to accelerated knowledge acquisition [17].

A common feature of the distance learning methods imposed during the lockdown is that they were based on online communication tools and platforms, built on remote presence (telepresence), and used a screen for organization. For educational researchers, distance learning methods used to support and organize the learning process of the students were well known [3,18–20].

However, the biggest challenge for the teacher is how to choose the teaching and learning methods, especially in the case of distance learning. For an experienced teacher, choosing the right teaching methods is not an easy task. These methods need to be adapted to the objectives of the lesson, the characteristics of the learners, and the content intended to be shared. It is therefore necessary to know the possibilities provided by each method, their effectiveness, and their use in achieving didactic objectives. It is important to note that, since the information society has only a gravitational core, and no stable structure or boundaries, the possibilities offered by digital pedagogies based on it, or their effectiveness, are also changing rapidly [21–23].

The traditional form of education, due to its classroom nature, can no longer meet the demands of modern learning. New challenges, as well as methodological and technological paradigm shifts, have emerged, first in industry, ICT, and social media, and then have infiltrated the education system.

The impact of these processes is not only felt in the 20th century, but also in the 21st century. The processes have not stopped, so that significant paradigm shifts in the teaching–learning process are also noticeable and can be empirically detected. Such modern models of learning, organization, and competence development are the technology–practice–environment context (TPACK) model and the SAMR model [24–26].

3. Hypothesis

The shift to online learning schedules during the lockdowns was a big challenge for teachers, students, and parents. It is hard enough to motivate students in face-to-face education, but it became even harder to find effective methods and tools to keep them motivated without physical contact. Most of the teachers were not familiar with this field. Online education and learning require a specific type of behavior: on one side, online learners need to be committed, and on the other side, they need to be able to self-regulate [27]. The teachers found it hard to assess the students' performance, grades went down, and it is likely that the learning outcomes worsened [28]. According to a literature review, the evidence that exists shows that teachers' views on ICT use for teaching and learning influence how often ICT is used in schools more than the availability of infrastructures. It can be argued that students who have teachers who are positive about ICT use in education but face low access and high barriers to using it at school report using ICT more often during lessons than students who have teachers who have high access to ICT but are less positive about its usefulness for teaching [29]. The use of different instruments depends on teacher-level inhibitors such as lack of teacher confidence, lack of ICT skills, lack of time, and lack of training [30].

The school system is in a transitional period where the old methods do not necessarily work, not least because of the digital divide. This gap consists of several elements. One of its components is economic, since the acquisition of digital tools that ensure a high level of experience (on a continuous basis) involves a significant financial investment. The other component is social. The extent to which an individual lives in harmony with technology, and the extent to which they master and possess the necessary knowledge for its proper use, depends on their status in society and their position in the labor market. Although the initial perception of the gap was based on generational differences, economic, social, and conscious tool use aspects should, in our opinion, also be taken into account, instead of this kind of generalization [31].

Based on the literature on the topic and experience, the authors have established five hypotheses during research efforts.

H1. *Teaching experience has a positive impact on the extent of the use of info-communication devices.*

H2. *Teachers participating in further digital training programs are significantly more receptive to the idea of developing digital content on their own.*

H3. *The type of host community has no impact on the use of info-communication methods.*

H4. *The completion of digital training programs has a positive effect on the use of info-communication devices in everyday teaching practice.*

H5. *The type of host community and participation in further training programs can impact the willingness to use info-communication devices in the education process.*

4. Methods

The aim of the empirical inquiry was to explore the state of digitization and the extent of the digital transformation among in-service teachers in Hungary with the help of a questionnaire-based half-structured interview administered online. It must be noted that only a few research programs with similar objectives and content have been performed and, due to the abovementioned factors, the respective results have become obsolete by now. The authors administered an online questionnaire-based survey to a large sample of pedagogues between 29 April and 10 May 2020 concerning the methodology of digital pedagogy.

The completion of the given questionnaire after the two-month-long digital instruction period introduced during the lockdown had a definite impact on the interpretation of the given research data, the hypothesis testing process, and the respective results. Consequently, broad-sweeping and comprehensive conclusions applicable to the Hungarian educational sphere as a whole cannot be drawn. Since digital instruction was implemented at all levels of the Hungarian education system, a control group was not established and comparative analysis of digitally scheduled and traditional classroom-based instruction was not performed either [12].

The survey was targeted at teachers working at educational institutions with a low ESL (early school leaving) index, resulting in the formation of a representative sample of institutions serving disadvantaged students in Hungary. In order to assure the heterogeneity of the sample, such factors as type of settlement or community, size of institution, and the early school leaving index were taken into consideration during sample compilation in a county-based breakdown.

The sample forming the foundation, or basis, of the survey was compiled within the framework of the Complex Basic Program (EFOP-3.1.2-16-2016-00001) aimed at reducing the rate of students' dropping out before completing their education. The definitive methodological component of the Complex Basic Program was the Differentiated Development in Heterogeneous Learner Groups. Accordingly, students formed groups, distributed responsibilities, worked together, and reported on the work of the group in a shared manner to the others. Eszterházy Károly Catholic University was the host of the program, and the authors of the article are professors or PhD students at the institution.

The authors used quantitative research methods to test the hypotheses. The larger objective was to assess the extent of digitalization in the ranks of the educational sphere. There are several limitations of the research that will be discussed further in the article.

The questionnaire focused on the following areas: digital transformation, the conscious use of digital devices in everyday practice, the main features of the learning environment, classroom activities, learning arrangement and methodology, the transmission of content, and educational materials. The scope of the research included the cognitive and affective impact of digital devices on student users, perspectives concerning the educational and informal use of digital devices, respective pedagogical experiences, and methodology-

related best practices, or, as summed up in other words: the characteristics of knowledge sharing online and offline.

One of the main questions of the research was to identify the online communication channels and digital platforms teachers found were effective in learning outcomes during the distance learning ordered because of the COVID-19 pandemic. The other main question of the survey was how specific classroom teaching methodologies could be replaced by online communication channels and digital media platforms during classroom extension. The study also sought to assess the experiences of distance learning in the period.

The size of the sample was selected from the basic multitude via a multi-step effort facilitated large sample-based data exploration. (The sample included pedagogues of schools from various counties participating in the Complex Basic Program). The questionnaire was forwarded electronically to 7000 teachers, and 10.7% provided a response. The questionnaire reviewed by the Digital Pedagogy Methodological Centre and the Educational Authority of Hungary was completed by 751 pedagogues online. The questionnaire is available at the following link https://tinyurl.com/digitalisatallas2020 (accessed on 2 April 2023).

The average age of the respondents is 48.78, 86% of the sample were female, and 14% were male (Figure 1).
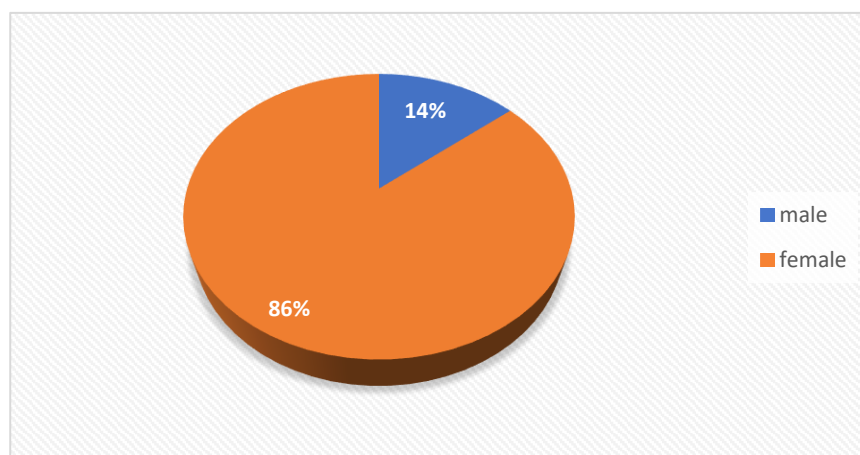

Figure 1. Gender of responders.

5. Results

The research inquired about the online communication channels and digital platforms providing effective learning support during the distance learning programs. It must be noted that, while the questionnaires were administered to teachers of schools with potentially high dropout rates, the preceding survey results show that both learners and teachers owned info-communication devices (laptops, desktops, tablets, or smartphones) deemed vital for learning in digital pedagogical environments.

While, in the case of the following questions, the research relied on a five grade Likert scale, due to the varying levels of digital proficiency in the Hungarian educator's body confirmed by the small sample pilot study performed before the actual research project, the scale had to be complemented with the I do not know category.

The question of which devices or approaches have proven to be effective in promoting the learning process in distance education programs was answered as the preparation and sharing of educational videos with students on the Internet. Number of respondents: *n* = 538.

Respondents confirmed the effectiveness of preparing and sharing educational or tutorial videos to promote the learning process. The results correlate with the principle of the pictorial turn and reinforce or substantiate our hypothesis concerning the increasing significance of digital media platforms in educational efforts.

Which devices or approaches have proven to be effective in promoting the efficiency of the learning process in the case of distance learning programs?—Writing subject blogs for students (i.e., WordPress, Wix, or Blog.hu). Number of respondents: *n* = 536. Since almost half of the respondents (48%) could not evaluate the efficiency of blogs, the respective data suggest that educators have not used professional or subject-related blogs in their teaching efforts. In total, 21% considered blogs effective, and 31% held neutral views or had a negative opinion concerning the effectiveness of blogs (Figure 2). In light of the increasing role of the Web 2.0 and openly editable platforms in content production and consumption since the middle of the first decade of the 21st century, the results are rather surprising, and the numbers tend to confirm that such approaches have not been fully accepted by the education community.
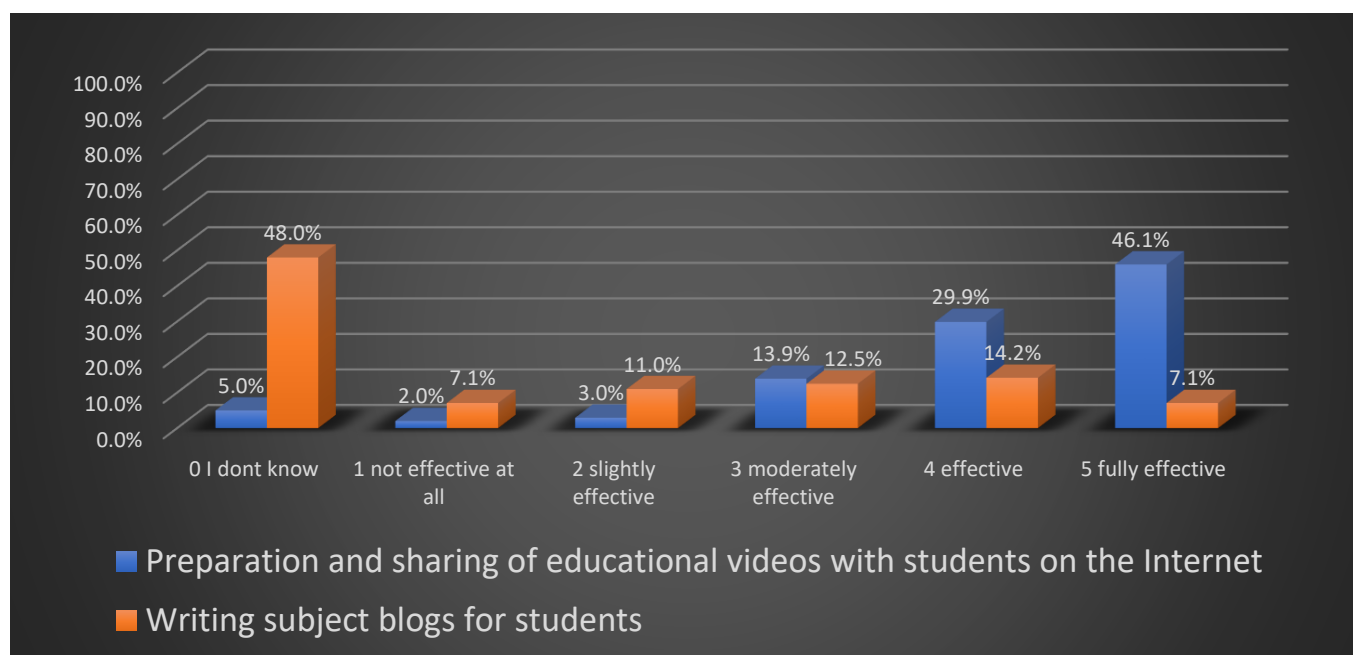

Figure 2. Preparation and sharing of educational videos with students on the Internet and writing subject blogs for students.

Which devices or approaches have proven to be effective in promoting the efficiency of the learning process in the case of distance learning programs?—Augmented reality spaces (i.e., Quiver). Number of respondents: *n* = 534 (Figure 3).

The authors assumed that augmented reality spaces represent a new approach and are enjoying increasing popularity in education since the second decade of the 21st century, and that they are used by a growing number of teachers. The results, however, indicated that only every fourth respondent was capable of evaluating this phenomenon, often interpreted as the new reality metaphor, and only 2% of those completing the questionnaire considered it effective for distance learning purposes.

Which devices or approaches have proven to be effective in promoting the efficiency of the learning process in the case of distance learning programs—Real-time virtual reality spaces (i.e., Minecraft)? Number of respondents: *n* = 534.

Much the same results were shown regarding the use of virtual-reality-based devices with a similar foundation to that of augmented reality tools. A total of 67% could not determine their efficiency in distance education programs and, compared with those accepting this technology (3%), twice as many respondents (6%) questioned their efficiency. The business sector considers the development of virtual reality devices a priority, while, in addition to producing VR games for leisure time and entertainment purposes, such as Minecraft, companies emphasize the use of VR in education as well. Nevertheless, research results show that schools have not yet taken advantage of this option.
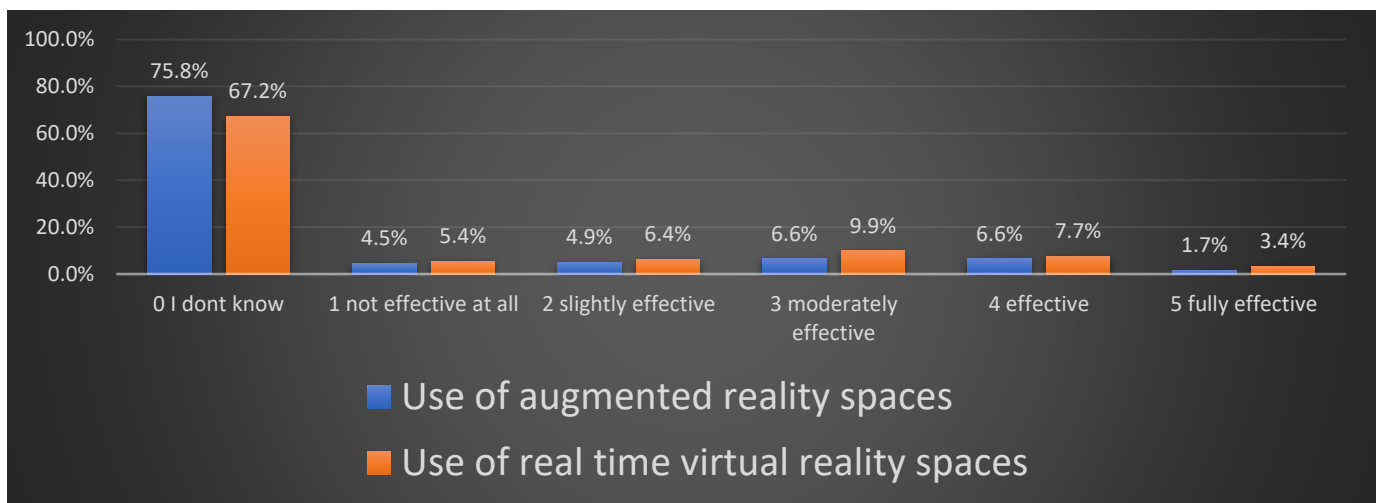
Figure 3. Use of augmented reality spaces.

Which devices or approaches have proven to be effective in promoting the efficiency of the learning process in the case of distance learning programs—Debate forums (i.e., moderated by each school separately). Number of respondents: *n* = 532.

Thirty-three percent of responders considered debate forums an effective approach for distance learning, 30% were neutral or had a negative view, while a rather high number, 37%, could not decide or had no opinion. Debate forums are asynchronous communication platforms facilitating a deferred or delayed form of pedagogical communication, but contrary to the assumptions, fewer respondents considered them useful.

Which devices or approaches have proven to be effective in promoting the learning process's efficiency in distance learning programs?—Written chat (i.e., Facebook Messenger). Number of respondents: *n* = 533 (Figure 4).

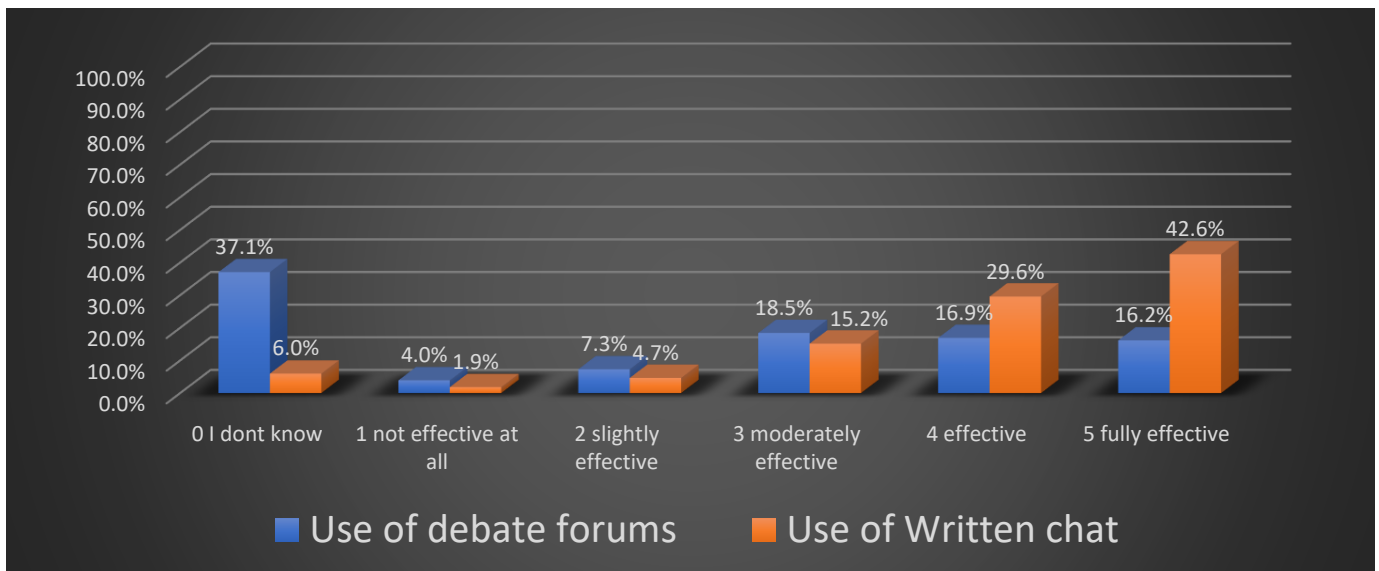**Figure 4.** Use of debate forums and use of written chat.

A significant difference can be discerned in the opinions considering real-time written chat facilitating synchronous pedagogical communication. While only 6% were undecided or had no opinion on their use in distance learning programs, almost three-quarters of the respondents (72%) considered them effective, while neutral or opposing views were rated at 22%.

The responses revealed that teachers consider the use of both video sharing platforms for educational purposes (distributing tutorial videos) and the chat option of social media, assuring fast, synchronous, and effective communication tools in distance education.

Which devices or approaches have proven to be effective in promoting the learning process's efficiency in distance learning programs?—Real-time video conference systems (i.e., Skype, Google Hangouts, Zoom). Number of respondents: *n* = 534.

In the case of the videos, the survey obtained pretty similar results to those of the written chat, although this synchronous communication form supporting visual interaction allows the participants access to their homes while expanding the classroom into the private sphere. Undecided respondents rated them a little higher at 13%, but 70% considered them useful, and only 16% were neutral or had a negative opinion. While the video conference has more determined technological parameters and requires a higher digital competence level than written chat, most respondents instinctively preferred video channels since visual communication can significantly strengthen social ties (Figure 5).
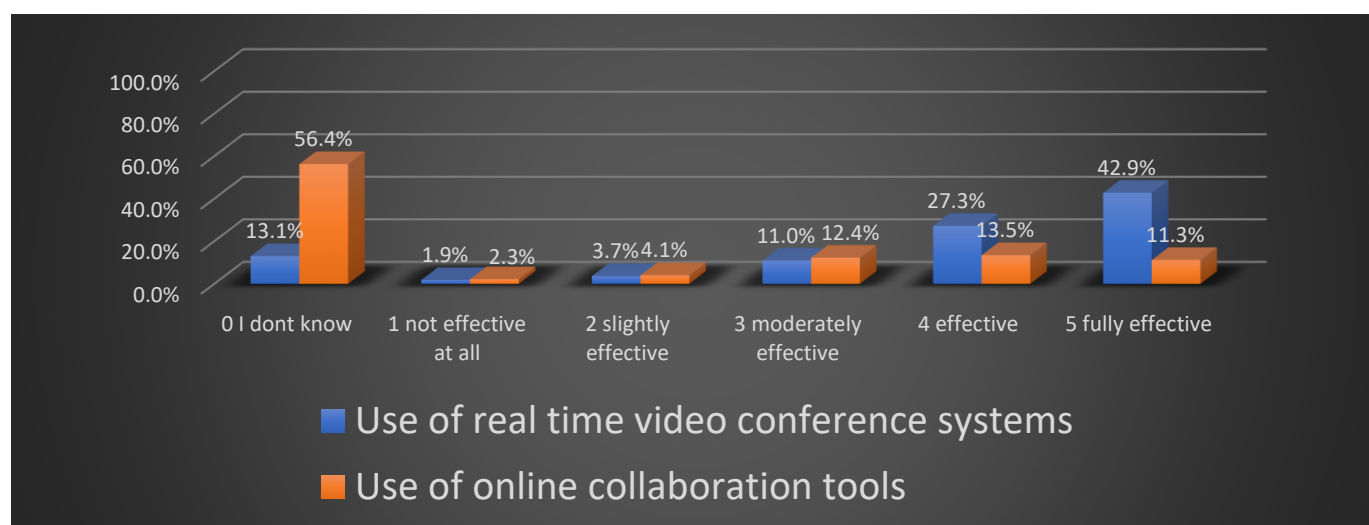

Figure 5. Use of real-time video conference systems and use of online collaboration tools.

Which devices or approaches have proven to be effective in promoting the learning process's efficiency in distance learning programs?—Online collaboration tools (i.e., Wikies). Number of respondents: *n* = 532.

Online collaboration and project work require strong and decisive instruction, intensive communication between students and teachers, and among students themselves. Consequently, and partly due to its novel nature, more than half (56%) of respondents could not determine its efficiency, and only one-quarter (25%) considered it effective, while 19% were neutral or had a negative opinion.

Which devices or approaches have proven to be effective in promoting the learning process's efficiency in distance learning programs?—Digital story telling (i.e., Adobe Slate). Number of respondents: *n* = 531.

Sixty-seven percent, or almost two-thirds of the respondents, could not determine the effectiveness of digital storytelling during distance education. The authors assume that the lack of knowledge concerning this approach is due to its novelty. Only 15% of the respondents considered it rather compelling. Since digital storytelling is built on a transmedial foundation, its use in education requires complex knowledge (Figure 6).

Which devices or approaches have proven to be effective in promoting the learning process's efficiency in distance learning programs?—Podcasts (i.e., Audacity, WavePad). Number of respondents: *n* = 528.
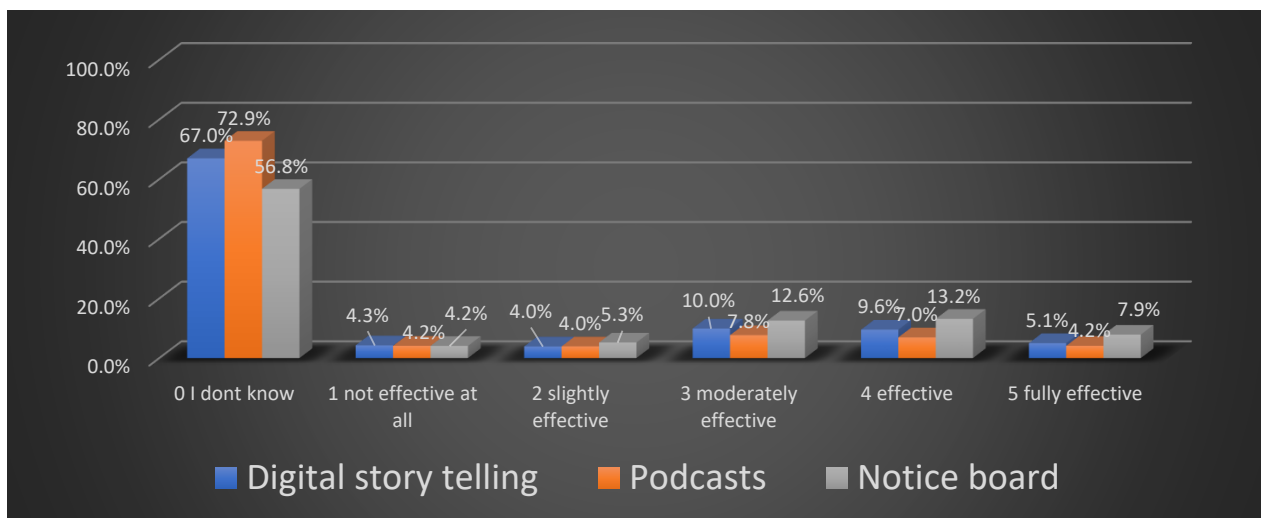
Figure 6. Use of digital storytelling podcasts and notice board.

In addition to augmented reality spaces, podcasts are the platforms users were least familiar with, as 73% of the respondents could not comment on the effectiveness of this approach. While more than three-quarters of the respondents (76%) considered educational videos as a useful component of distance learning, in sound-based podcasts, the approval rate was only 11%. The respective data substantiate the applicability of the image-based turn principle. Consequently, while preparing a podcast requires a lower amount of preparation, this format is lesser known, even in online media environments. Which devices or approaches have proven to be effective in promoting the learning process's efficiency in distance learning programs?—Notice board (i.e., Padlet, Trello).

The online notice boards reflect the philosophy of Tim Berners-Lee, the creator of the World Wide Web. Accordingly, the information society should provide a platform for sharing ideas along with association-oriented categorization efforts. The survey revealed that 57% of the respondents could not determine the efficiency of this approach, and only 21% considered online notice boards useful.

H1. *Teaching experience has a positive impact on the extent of the use of info-communication devices*

Most of the respondents (96%) teach in primary school (Table 1). Regarding teaching experience, the sample shows normal distribution. Respondents mainly included primary school teachers, and the sample contained only a low number of pre-school and secondary school educators. (The network contacted does not have separate special schools; students with disabilities attend regular schools according to the complex instruction program). The descriptive statistical indicators, that is, the values of Skewness and Kurtosis, are between negative one and one (Table 2).

Table 1. School type.

School Type	Number of Respondents
kindergarten	4
primary school	664
vocational school	2
secondary vocational school	8
secondary technical school	4
secondary grammar school	8
other	0
total	690

Table 2. Descriptive Statistics.

	n	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Years of teaching experience?	695	1	58	23.82	11.298	375	0.093	−0.859	0.185
Valid N (listwise)	695								

To substantiate the hypothesis, it was necessary to process and analyze the answer of the teachers to the question: How often did you or your students use the following devices and methods during the digital education schedule introduced in the spring of 2020?

Respondents considered nine technical devices and eight methods during their answer:

- Mobile applications;
- Personal or portable computer (laptop) provided by the institution;
- Own digital device;
- Digital devices provided to students by the institution (laptop, tablet, mobile phone);
- Students' own digital devices;
- Printed paper-based materials;
- 3D printer;
- Robots;
- Smartboard, interactive board.

  Methods

- Online test writing, quizzes;
- Issuing home assignments online;
- Solving tasks and problems with students' smart devices;
- Group work;
- Student presentations;
- Extracurricular collaboration of students online;
- Gamification of learning activities (inclusion of games or game-based methods in the education process);
- Other.

The correlation test revealed a significant, yet negative, correlation between two devices and one method. Consequently, this implies the rejection of the hypothesis entailing the positive impact of teaching experience on the extent of the use of info-communication devices. Thus, teachers with less experience, that is, younger colleagues, tend to use the following devices more frequently:

Mobile applications (r = −0.102; *p* = 0.22; *n* = 506);

- Robots (r = −0.136; *p* = 0.02; *n* = 500);
- Online tests, quizzes (r = −0.144; *p* = 0.01; *n* = 517).
- Correlation could not be identified in the case of the other devices or methods.

It should also be explored whether the given job position shows correlation with the frequency of info-communication device use. The examination of the abovementioned nine technological devices and eight methods in light of the given position yields surprising results. The distribution of the answers appears to be uniform, as no significant differences can be discerned. Although age differences can impact the answers, the respective answer categories show only a 10% digression, as the respondents either use or refuse to deploy info-communication devices.

Mobile Applications

The answers reveal that half of the respondents use mobile applications daily during teaching (Figure 7).
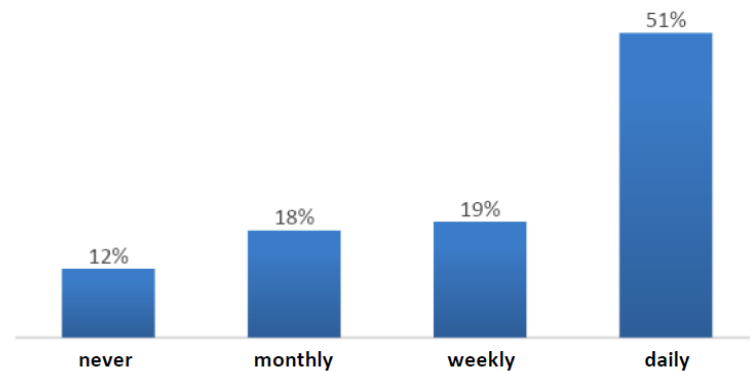
Frequency of mobile application use

Figure 7. Frequency of mobile application use.

The job description or position-specific breakdown of the data reveals similarities:

The cross-table analysis reveals that half of the respondents (50% or more) use mobile applications in all positions. While the use rate is higher with primary school teachers, in the case of secondary school teachers and institutional managers or principals, the respective value is 5–8% lower (Table 3).

Table 3. Correlation between job position and digital device use (crosstabulation).

			Mobile Applications Use				Total
			Never	**Monthly**	**Weekly**	**Daily**	
Position	lower primary school teacher	Count	32	34	42	115	223
		% within $All	14.3%	15.2%	18.8%	51.6%	
	day-care teacher	Count	6	6	7	25	44
		% within $All	13.6%	13.6%	15.9%	56.8%	
	upper primary school teacher	Count	27	54	58	139	278
		% within $All	9.7%	19.4%	20.9%	50.0%	
	high school teacher	Count	2	4	6	10	22
		% within $All	9.1%	18.2%	27.3%	45.5%	
	principal	Count	1	1	9	8	19
		% within $All	5.3%	5.3%	47.4%	42.1%	
	vice principal	Count	4	9	5	15	33
		% within $All	12.1%	27.3%	15.2%	45.5%	
Total		Count	56	87	94	247	484

Percentages and totals are based on respondents. Dichotomy group tabulated at value 1.

Answers related to teachers' use of institution-provided personal or portable computers show that 24.6–29.5% of lower primary school teachers do not have such devices. In comparison, in the case of teachers at upper primary schools and in secondary schools, the given value is 18,6% and 12%, respectively. The distribution of daily use is rather consistent, indicating a use rate of 68.8–76.2%.

While the survey revealed that 87.9–95.8% of the respondents use their own digital devices on a daily basis, reliance on digital devices is more prevalent in primary schools. Somewhat surprisingly, the lowest frequency of use was displayed in the case of the leaders of educational institutions (Table 4).

Table 4. Correlation between job description (position) and digital device use (crosstabulation).

Munkakörök és a Digitális Eszközhasználat Kapcsolata (Crosstabulation)			Own Digital Device				Total
			Never	Monthly	Weekly	Daily	
Position	lower primary school teacher	Count	4	5	5	218	232
		% within $All	1.7%	2.2%	2.2%	94.0%	
	day-care teacher	Count	0	1	1	46	48
		% within $All	0.0%	2.1%	2.1%	95.8%	
	upper primary school teacher	Count	7	13	10	258	288
		% within $All	2.4%	45%	3.5%	89.6%	
	high school teacher	Count	1	1	0	24	26
		% within $All	3.8%	3.8%	0.0%	92.3%	
	principal	Count	0	3	0	17	20
		% within $All	0.0%	15.0%	0.0%	85.0%	
	vice principal	Count	1	2	1	29	33
		% within $All	3.0%	6.1%	3.0%	87.9%	
Total		Count	12	20	15	458	505

Percentages and totals are based on respondents. Dichotomy group tabulated at value 1.

The given trends are discernible. Henceforth, the previously demonstrated high frequency of device use leads to decreasing reliance on traditional methods. Printed or paper-based educational materials are not used by one-quarter of primary school teachers (23.9–30.9%) at all. Furthermore, 21.2–25% of institution managers or principals discard such materials and, surprisingly, the lowest rate of eliminating the use of printed materials is seen among secondary school teachers at 16,7%. It was confirmed that the majority of respondents only use such educational materials monthly.

Robot technology and 3D printing, however, are considered new developments. In total, 95,6% of respondents do not use robot technology at all. While the methodology of lower and upper primary school teachers includes this approach, those who have access to robots (4.4%) use them weekly, while 92–95% of respondents have never used 3D printing, and 12% of the sample use this approach in secondary schools monthly.

Inquiring about the use of interactive boards also provides surprising results, as only 10% of the respondents rely on them daily, and the number of those who never used such a device is exceedingly high (Table 5).

Administration of online tests or quizzes typically appears weekly and monthly. One-fifth of the respondents do not use it, while in the case of upper primary school teachers this rate is only 9.6%. Moreover, all managers and principals use this method.

Issuing online assignments had become an established and frequently used methodological component by May 2020. Only 1.9% of the respondents refrain from using this approach. As far as distribution is concerned, it is most characteristic of primary education and it gradually declines with the progression toward secondary school instruction (Figure 8).
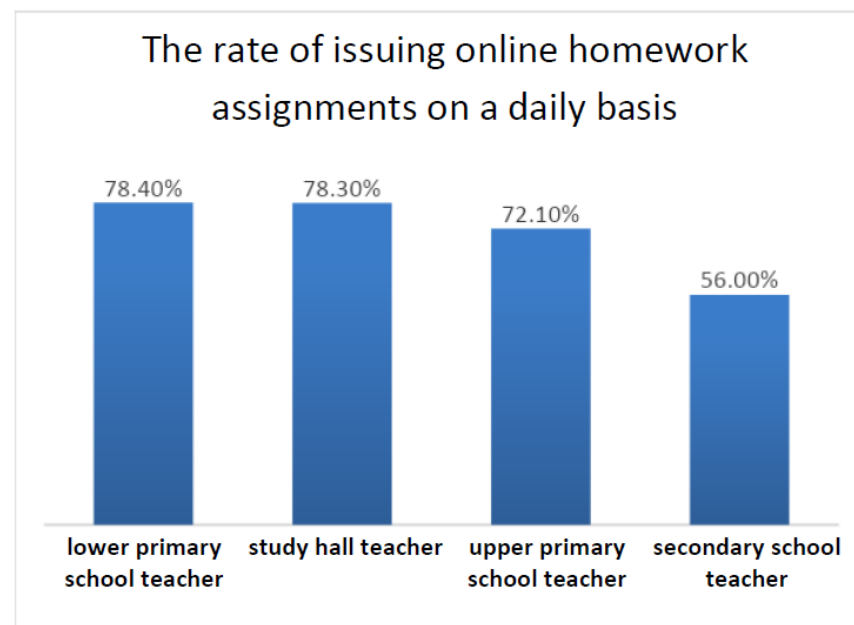
Having analyzed the category of task or assignment solving with the students' own device, similar conclusions can be made. Namely, in the case of lower primary education, this method is used daily and, as we progress toward the higher grades, weekly use becomes prevalent.

In total, 37.8–46.2% of respondents do not use online group work, and the rest of the sample relies on this method only on a monthly basis.

Table 5. Correlation between job description (position) and digital device use (crosstabulation).

| | | | Smartboard, Interactive Board | | | | Total |
			Monthly	Weekly	Daily	Never	
Position	lower primary school teacher	Count	162	25	12	24	223
		% within $All	72.6%	11.2%	5.4%	10.8%	
	day-care teacher	Count	27	6	3	7	43
		% within $All	62.8%	14.0%	7.0%	16.3%	
	upper primary school teacher	Count	205	22	14	28	269
		% within $All	76.2%	8.2%	5.2%	10.4%	
	high school teacher	Count	14	4	3	4	25
		% within $All	56.0%	16.0%	12.0%	16.0%	
	principal	Count	14	3	1	2	20
		% within $All	70.0%	15.0%	5.0%	10.0%	
	vice principal	Count	20	6	3	3	32
		% within $All	62.5%	18.8%	9.4%	9.4%	
Total		Count		50	29	46	481

Percentages and totals are based on respondents. Dichotomy group tabulated at value 1.

Figure 8. The rate of issuing online homework assignments on a daily basis.

Surprisingly, student presentations are already used in lower primary school, as 63.2% of 228 lower primary school teachers rely on this method. As far as all age groups are concerned, monthly use appears to be most typical.

In the case of students' extracurricular collaboration, consistent distribution can be discerned. The scale reveals that approximately one-quarter of teachers for all age groups of the "non-user, monthly user, weekly user, and daily user" scale deploy this method. The gamification of learning activities is mostly characteristic of lower primary school instruction and its application in the upper primary and secondary grades significantly decreases. This factor is definitely worthy of consideration (Table 6).

Table 6. Correlation between job description (position) and digital device use (crosstabulation).

			Gamification of Learning Activities				Total
			Monthly	Weekly	Daily	Never	
Position	lower primary school teacher	Count	5	19	78	127	229
		% within $All	2.2%	8.3%	34.1%	55.5%	
	day-care teacher	Count	0	6	17	21	44
		% within $All	0.0%	13.6%	38.6%	47.7%	
	upper primary school teacher	Count	9	62	134	77	282
		% within $All	3.2%	22.0%	47.5%	27.3%	
	high school teacher	Count	3	8	9	6	26
		% within $All	11.5%	30.8%	34.6%	23.1%	
	principal	Count	1	3	10	6	20
		% within $All	5.0%	15.0%	50.0%	30.0%	
	vice principal	Count	0	7	15	11	33
		% within $All	0.0%	21.2%	45.5%	33.3%	
Total		Count		86	203	193	498

Percentages and totals are based on respondents. Dichotomy group tabulated at value 1.

H2. *Teachers participating in further digital training programs are significantly more receptive to developing digital content on their own.*

The survey aimed to assess the need of pedagogues to develop their digital content with the methods described below:

- Preparing online worksheets and tests (i.e., Redmenta, Kahoot);
- Demonstration of correlations in Mathematics and Physics (i.e., GeoMatech, LabView);
- Processing educational materials with tests, worksheets, and educational videos (i.e., Zanza.tv,);
- Thematic websites, blogs focusing on digital methodological options (i.e., tanárblog.hu);
- The creation and presentation of virtual spaces and forms (i.e., Minecraft);
- Language learning on an individual basis (i.e., Duolingo);
- Preparing animations and videos (i.e., PhotoPeach);
- Preparing presentations (i.e., Prezi.com, Google slides);
- Other methods—webinars, video channels.

The hypothesis was substantiated in the case of only two methods:

- Preparing online worksheets and tests (i.e., Redmenta, Kahoot) (Chi-square = 13.053, $p = 0.11$) (Table 7);
- Demonstration of correlations in Mathematics and Physics (i.e., GeoMatech, LabView) (Chi-square = 11.754, $p = 0.019$).

The Chi-square test confirms that the values of the table are significant. A total of 86,4% of the pedagogues and 83% themselves prepared such digital content, and in the case of those who participated in digital training, the willingness to produce content was three times higher than those not taking advantage of this option.

The answers to the other questions are more evenly distributed and the significance analyses did not reveal discernible results. In total, 16% of teachers did not consider the production of their own presentation necessary and 28% stated that they had not possessed the knowledge required to create digital presentations. (However, 71,6% of these teachers had already participated in digital training programs).

Table 7. Crosstab.

		Count		
		Participation in Teacher Training on Digital Issues		**Total**
		yes	**no**	
	I do not consider it necessary to develop my content	4	9	13
	I would need my content, but I do not have the necessary competences	4	1	5
Preparation of worksheets, tests (i.e., redmenta.com, (accessed on 3 April 2023) Kahoot)	I need to produce my own content; occasionally I produce new content myself	2	2	4
	I need to produce my own content, and when I can, I produce new content myself	10	3	13
	I think that making my own content is necessary, I inspire others with my work and help them develop new content	75	23	98
	Total	95	38	133

H3. *The type of host community has no impact on the willingness to use info-communication methods.*

The Chi-square probe exploring the zero hypothesis did not indicate a significant correlation. Thus, the hypothesis cannot be discarded and the original statement is substantiated, according to which there is no correlation between the two variables.

H4. *The completion of digital training programs positively affects the use of info-communication devices in everyday teaching practice.*

The hypothesis was substantiated by statistical indicators (Chi-square = 2.174, p = 0.537) Consequently, three times as many teachers participating in further training programs with a digital theme applied digital methods compared with their colleagues not attending such programs, and in the case of pedagogues forgoing such courses, the distribution was equal (Table 8). The number of the teachers who have used digital solutions before the lockdown in not affected by the location of the school (Figure 9).

H5. *The type of host community and participation in further training programs can impact the willingness to use info-communication devices in the education process.*

The hypothesis was not substantiated (Chi-square = 2.174, p = 0.537). Consequently, the type of the host community and participation in digitally themed additional training programs do not impact the willingness to apply info-communication methods (Table 9).

Table 8. I have already implemented and used digital solutions before the introduction of the digital instruction schedule in spring 2020.Training program for pedagoguesdigtech crosstabulation.

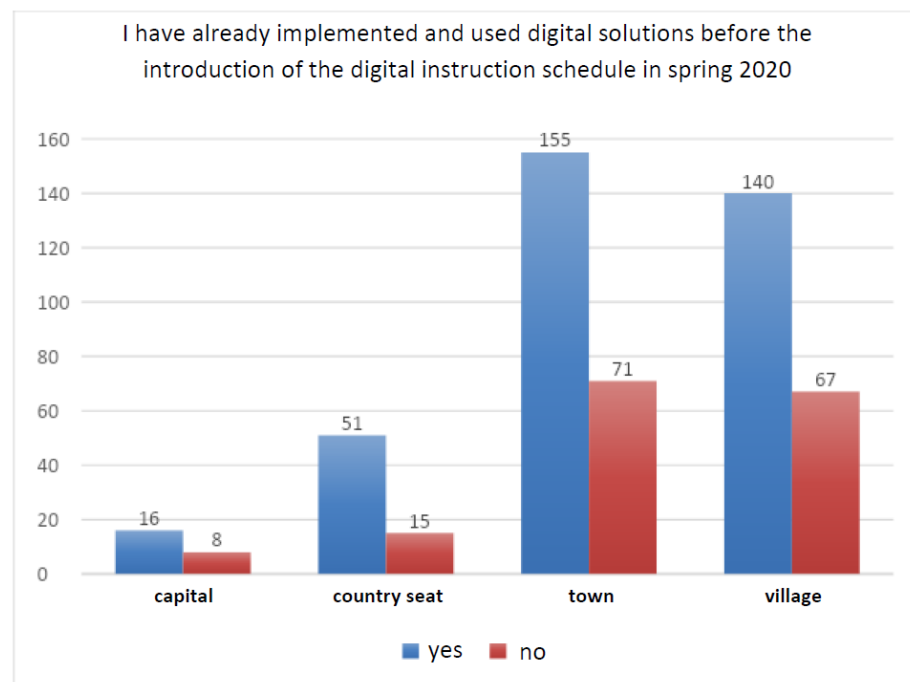|		**Count**		
		Participation in Teacher Training on Digital Issues		**Total**
		yes	**no**	
Have you introduced a digital solution into your teaching practice ahead of the digital extracurricular work program starting in spring 2020?	**yes**	307	66	373
	no	108	58	166
	Total	415	124	539

Figure 9. Number of teachers who have already implemented and used digital solutions before the introduction of the digital instruction schedule in spring 2020.

Table 9. Settlement type I have already implemented and used digital solutions before the introduction of the digital instruction schedule in spring 2020. Pedagogue further training_digtech crosstabulation.

		Count			
Participation in Teacher Training on Digital Issues			**Have You Introduced a Digital Solution into Your Teaching Practice ahead of the Digital Extracurricular Work Program Starting in Spring 2020**		**Total**
			Yes	**No**	
Yes	Settlement type	Capital	9	5	14
		city with county rights	39	9	48
		City	127	44	171
		municipality/community	122	46	168
	Total		297	104	401
No	Settlement type	Capital	7	3	10
		city with county rights	12	6	18
		City	28	27	55
		municipality/community	18	21	39
	Total		65	57	122
Total	Settlement type	Capital	16	8	24
		city with county rights	51	15	66
		City	155	71	226
		municipality/community	140	67	207
	Total		362	161	523

6. Discussion

The research presented explored which online communication channels and digital platforms Hungarian teachers considered effective during the distant education introduced as a response to the COVID-19 pandemic. It can be concluded that, despite the emergence of digitalization and the popularity of online communication channels among the public and generally used digital platforms, a paradigm shift did not take place in Hungarian schools.

Respondents stated that the most effective means of instruction in the augmented online classroom included self-prepared educational video content and real-time written and video-based chat. Platforms with more limited impact included blogs, debate forums, and cloud-based cooperative spaces. The least effective means were augmented and virtual reality spaces, notice boards, digital storytelling platforms, and podcasts. Respondents appeared to be most uncertain in the case of augmented and virtual reality spaces, debate forums, online collaboration platforms, digital storytelling, podcasts, and digital notice boards. This leads to the conclusion that the teachers have not tried these platforms.

The study attempted to highlight universally deployable digital options and framework systems determining the foundations of digital instruction schedules implemented and delivered online. The respective support systems and methodological solutions provide viable options for society as a whole. In the second wave of the COVID-19 epidemic, these promising approaches had already been implemented and were able to contribute to the efficiency of the education process. It is recommended that the given methodological arsenal be adapted by everyone according to their own needs. The same conclusion can be drawn from the results of the empirical examinations investigating the opinion of students who were provided all necessary support for functioning effectively in the context of digital school. While a variety of technological and methodological models have been introduced, these approaches should be reconsidered periodically.

7. Limitations and Conclusions

The results are strongly limited. Because of the local nature of the sampling and the lack of control measurements, the general relevance and application of the results is limited to Hungary and, in the absence of research with a similar focus, comparison with it is not possible at this stage. While the authors are aware that other elements of the public education system may need to be adapted, they felt it was important to explore the key views needed for optimal online teaching and learning to ensure the continuity of education.

Further studies should examine whether having online live classes for five days a week all day long makes students lose motivation because it takes away the positive aspect of digital education, which fosters independent learning and self-regulation. At the moment, it can be concluded that digital distance education can only be effective as a necessary solution; it cannot replace face-to-face education, and it cannot develop many essential competencies. The study showed that most of the Hungarian teachers surveyed are satisfied with the equipment used for online teaching. The survey confirmed a noteworthy development related to using digital devices and applications in Hungary. Accordingly, mobile applications tend to be preferred by instructors and learners of higher-level education institutions, while teachers and students of lower-level education institutions tend to use their own devices for learning through online tasks. Smart systems that will emerge due to the changes brought about by digitalization processes will require more profound digital competencies in addition to digital, technical, and ICT skills. While gamification is primarily a methodological approach for teaching lower age groups, it is virtually non-existent in the case of secondary education.

The vast majority of teachers participating in our research teach in lower grades. In this form, their answers also relate to the age characteristics of elementary school students. The digital world enriches many things that children in elementary school learn from their senses and doing things at the elementary school. This is a place where they do not just obtain facts and answers, but they try things out, do activities that suit them, make things

with their friends, and obtain feedback from their teacher. These activities help them grow and learn more skills for later in life. They also help them enjoy and work better in the digital world. Another characteristic feature of the lower school age group is the need for immediate feedback. Every activity, achievement, and failure of a primary school child is characterized by the need for an immediate reaction from their environment, but mostly from their parents and teacher. In the digital environment, immediate feedback is extremely easy to implement. One of the main characteristics of digital teaching materials, as well as one of the main criteria of good digital teaching materials, is the existence of immediate feedback and rewards.

References

1. Hargitai, D.M.; Sasné Grósz, A.; Veres, Z. Traditional and online learning preferences in higher education—Challenges posed by the COVID-19 epidemic. *Stat. Rev.* **2020**, *98*, 839–857. [CrossRef]
2. Orosz, B.; Kovács, C.; Karuovic, D.; Molnár Gy Major, L.; Vass, V.; Szűts, Z.; Námesztovszki, Z. Digital education in digital cooperative environments. *J. Appl. Technol. Educ. Sci.* **2019**, *9*, 55–69. [CrossRef]
3. Crawford, J.; Butler-Henderson, K.; Rudolph, J.; Malkawi, B.; Glowatz, M.; Burton, R.; Magni, P.A.; Lam, S. COVID-19: 20 countries' higher education intra-period digital pedagogy responses. *J. Appl. Learn. Teach.* **2020**, *3*, 1–20. [CrossRef]
4. Benedek, A. Distance learning differently For the pedagogical challenges of the digital age. *Opus Et Educ. Work. Educ.* **2020**, *7*, 185–192.
5. Kivunja, C. Embedding Digital Pedagogy in Pre-Service Higher Education to Better Prepare Teachers for the Digital Generation. *Int. J. High. Educ.* **2013**, *2*, 131. [CrossRef]
6. Lewin, D.; Lundie, D. Philosophies of digital pedagogy. *Stud. Philos. Educ.* **2016**, *35*, 235–240. [CrossRef]
7. Clarke, T.; Clarke, E. Born digital? Pedagogy and computer-assisted learning. *Educ. Train.* **2009**, *51*, 395–407. [CrossRef]
8. Kővári, A. Synergy of digital society and digital education. *Civ. Rev.* **2020**, *17*, 69–72.
9. Siemens, G. Connectivism: A learning theory for the digital age. *Int. J. Instr. Technol. Distance Learn.* **2005**, *2*, 3–10.
10. Csapó, B. Education for the information society. (Instruction and the information society). *Hung. Sci.* **2003**, *48*, 1478–1485.
11. Racsko, R. *Digital Transformation in the Education Process*; School Culture, Thought Publishing: Budapest, Hungary, 2017; p. 328.
12. Government Decision No 1102/2020 (14 March) Implementing Remote Learning Outside the Classroom in General (Public) Education and VET Institutions due to Covid-19 1102/2020. (III. 14.) Governmental Decree on the Introduction of New Work Schedules in Public Education and Vocational Training Institutions Due to the Corona Virus. Available online: https://www.cedefop.europa.eu/en/news/hungary-national-vocational-education-and-training-vet-responses-covid-19 (accessed on 2 April 2023).
13. Blees, I.; Rittberger, M. Web 2.0 Learning Environment: Concept, Implementation, Evaluation. *Elearning Pap.* **2009**, *15*. [CrossRef]
14. Buda, A. *Educators in the Digital Age: Trend Research in Schools in a Big City*; Thought for Rent Publishing: Budapest, Hungary, 2020; p. 265. ISBN 9789635560554.
15. Ujbanyi, T.; Sziladi, G.; Katona, J.; Kovari, A. ICT Based Interactive and Smart Technologies in Education—Teaching Difficulties. In Proceedings of the 229th International Conference on Education and E-learning (ICEEL), Bangkok, Thailand, 2–4 November 2017; pp. 39–44.

16.   Benedek, A. (Ed.) *Digital Pedagogy 2.0*; Typotex Publishing: Budapest, Hungary, 2013; p. 312.

17.   Szűts, Z. Phenomena and Manifestations of Digital Pedagogy. *New Pedagog. Rev.* **2020**, *5–6*, 15–38.

18.   Greenhow, C.; Lewin, C.; Willet, K.B.S. The educational response to COVID-19 across two countries: A critical examination of initial digital pedagogy adoption. *Technol. Pedagog. Educ.* **2020**, *30*, 7–25. [CrossRef]

19.   Lancet, T. COVID-19: Learning from experience. *Lancet* **2020**, *395*, 1011. [CrossRef]

20.   Dhawan, S. Online Learning: A Panacea in the Time of COVID-19 Crisis. *J. Educ. Technol. Syst.* **2020**, *49*, 5–22. [CrossRef]

21.   Saw, K.G.; Majid, O.; Ghani, N.A.; Atan, H.; Idrus, R.M.; Rahman, Z.A.; Tan, K.E. The videoconferencing learning environment: Technology, interaction and learning intersect. *Br. J. Educ. Technol.* **2008**, *39*, 475–485. [CrossRef]

22.   Chen, Y.; Willits, F.K. Dimensions of educational transactions in a videoconferencing learning environment. *Am. J. Distance Educ.* **2009**, *13*, 45–59. [CrossRef]

23.   Ferri, F.; D'Andrea, A.; Grifoni, P.; Guzzo, T. Distant Learning: Open Challenges and Evolution. *Int. J. Learn. Teach. Educ. Res.* **2018**, *17*, 78–88. [CrossRef]

24.   Serfőző, M.; Golyán, S.; Lassú, Z.F.; Svraka, B.; Aggné Pirka, V. Digitization and Online Learning in Teacher Education—Student Feedback on Absence Education. *Civ. Rev.* **2020**, *17*, 103–114.

25.   Orosz, B. Learner Experiences Related to Digital Education Schedules in Light of Empirical Data. *Acta Polytech. Hung.* **2022**, *18*, 141–157. [CrossRef]

26.   Pérez, L.; Victoria, M.; Pérez, L.; Carmen, M.; Rodríguez-Ariza, L. Blended learning in higher education: Students' perceptions and their relation to outcomes. *Comput. Educ.* **2011**, *56*, 818–826. [CrossRef]

27.   Józsa, G.; Karáné, M.N.; Józsa, K. Teachers' experiences of motivating students during the COVID-19 epidemic. *Child Educ. Online Sci. J.* **2021**, *9*, 169–186.

28.   Kollár, N. Teachers' experiences and practices of online education. *Sch. Cult.* **2021**, *31*, 23–53. [CrossRef]

29.   Sanjay, N.; Laxman, K. Factors inhibiting teachers' embracing elearning in secondary education: A literature review. *Asian J. Distance Educ.* **2019**, *14*, 124–143.

30.   Balanskat, A.; Blamire, R.; Kefalla, S. The ICT Impact Report: A Review of Studies of ICT Impact on Schools. 2007, in Europe. Available online: http://insight.eun.org/ww/en/pub/insight/misc/specialreports/impact_study.htm (accessed on 2 April 2023).

31.   Prievara, T.; Lénárd, A.; Katona, N. *Digital Pedagogy in Public Education Education 2030*; Eszterházy Károly University: Eger, Hungary, 2020.