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ARTICLE

Digital Educational Space in the Opinion of Secondary School Students and Teachers

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ABSTRACT

Contemporary education increasingly relies on digital technologies, which influence the organisation of teaching and learning. The study aimed to explore the opinions of secondary school students and teachers on the functioning of the digital learning space and to identify factors influencing its effectiveness. The study was conducted among 380 teachers and 600 secondary school students from the Greater Poland Voivodeship. The results showed that the surveyed students had a comparable level of digital competence to their teachers and were more likely to positively assess the effectiveness of teaching using digital tools. The most frequently used solutions were presentation software, educational websites, and communication applications. The main advantages of the digital learning space included easy access to educational materials and the ability to learn at any time, while the most significant threats included information chaos and the lack of direct teacher-student contact. Both students and teachers positively assessed the impact of technology on the attractiveness of classes, access to knowledge, and communication. A statistical correlation was also demonstrated between the assessment of the functioning of the digital learning space and the socio-demographic characteristics of the participants. The results confirmed the need to increase the quantity and quality of teacher training, expand technical and IT infrastructure in schools, and more systematically use digital tools. The digital educational space has enormous development potential, but its effective use requires maintaining a balance between technology and traditional teaching methods, so as to support, rather than replace, teacher-student contact.

Keywords: Digitisation; Educational Space; Statistics; Digital Education; Digital Literacy; Teaching Effectiveness

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1. Introduction

Contemporary education operates in a dynamically changing socio-technological environment, in which information and communication technologies play an increasingly important role. The digitization of everyday life, accelerated by remote learning experiences, has influenced the organization of the teaching process, the relationships between participants, and access to knowledge. In this context, the concept of a digital educational space, understood as an environment in which teaching and learning processes using digital tools take place, is particularly important. The choice of the topic, “Digital Educational Space in the Opinion of Secondary School Students and Teachers”, stems from the need for an in-depth analysis of this phenomenon, particularly from the perspective of its primary users—students and teachers. Their experiences, attitudes, and opinions can provide a valuable source of knowledge about the effectiveness of implemented solutions and directions for the further development of digital education.

The main goal of this study is to understand and analyze the opinions of secondary school students and teachers regarding the functioning of the digital learning space, as well as to identify factors influencing its effectiveness. Therefore, the following specific objectives were formulated: determining the level of use of digital tools in the teaching process, examining the perceived benefits and threats resulting from the digitalization of education, comparing the opinions of both research groups, and identifying the relationships between selected variables. The following research questions are aimed at achieving these goals:

- 1) What digital tools and platforms are most frequently used by secondary school students and teachers?
- 2) How do teachers and students assess the functioning of the digital educational space?
- 3) How do teachers perceive the role of digital technologies in the teaching process?
- 4) What are the similarities and differences in the opinions of students and teachers?
- 5) Are there statistically significant relationships between the selected variables?

The structure of the work is guided by the adopted research objectives and comprises six theoretical and empirical sections. Section 1 is an introduction to the topic. Section

2 is theoretical and discusses the concept of digital educational space. It presents the definition and essence of this concept and the development of information and communication technologies in education. Furthermore, it identifies the most important opportunities and threats related to the digitization of education.

Section 3 presents the methodological assumptions of the study. It defines the subject and scope of the study, the methods, techniques, and research tools used, and characterizes the research group of secondary school students and teachers. It also outlines the organization and conduct of the study. Section 4 is empirical in nature and presents the results of the conducted research. It includes an analysis of the level of use of digital tools, student and teacher opinions on the digital educational space, and a comparison of results between the study groups. This section also includes a statistical analysis of the data. Section 5 is devoted to a discussion of the obtained results, interpreting them and relating them to the existing literature on the subject. The work concludes with a conclusion, presenting final conclusions, recommendations for educational practice, and suggestions for directions for further research.

Some of the conceptual elements of this study echo the author’s earlier work. However, this article introduces new data and an extended time horizon.

2. Digital Educational Space—A Theoretical Approach

The purpose of this section is to introduce fundamental issues related to education in the age of digitalization. It begins by explaining the concept of digital learning space, a virtual environment in which teaching and learning take place using advanced information and communication technologies. It then discusses the dynamic development of these technologies in the context of education, which has transformed traditional teaching and learning methods, creating new opportunities and challenges for teachers and students. The final section presents both the opportunities brought by the digitalization of education, such as unprecedented access to knowledge and increased interactivity, and the potential threats related to digital exclusion, data security, and motivation and concentration problems.

2.1. Explaining the Concept of Digital Learning Space

The term “Internet” refers to the network infrastructure connecting servers and clients via optical fibers, satellites, telephone networks, and other technologies. The Internet therefore has physical, material characteristics—it meets the criteria of location and spatial resistance. Digital space, on the other hand, is created from data generated by using the network, other solutions using the Internet, for example, blockchain technologies, and computer technologies that do not need to be connected to the Internet (virtual reality, mixed

reality)^[1] (p. 22). This type of space also includes computer programs (codes that create, verify, monitor, and control) that shape the material world^[2] (p. 206). According to K. Janc^[1] (p. 22), digital space is a creation created or functioning thanks to the Internet. Technologies creating digital space are inextricably linked to the Internet and determine its increased usability^[3].

The issues related to digital space can be viewed from the following two perspectives: digital space understood as a source of information and understood as a subject of research—**Figure 1**.

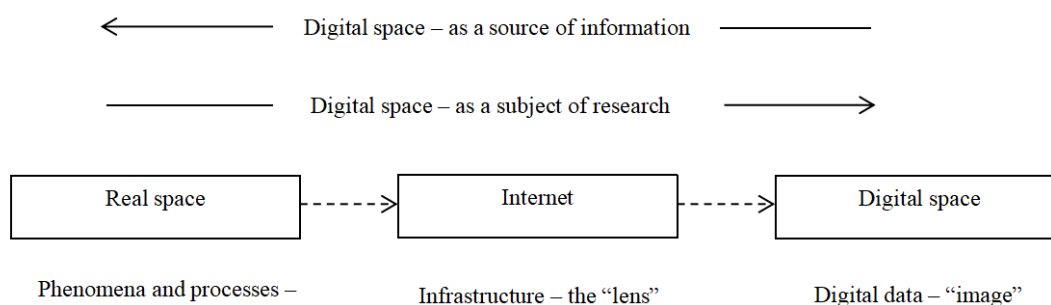


Figure 1. Relationships between real and digital space^[1] (p. 24).

As can be seen, these approaches will be complementary, as both emphasize the existence of mutual relations between real space and the Internet, and between real space and digital space. The fundamental difference between these approaches lies in the different orientation of information flow between the two forms of space^[4]. Digital space is created by people who use the Internet, as a result of the operation of devices connected to the Internet, as well as other computer technologies. It is a digital representation of human interaction and automatically generated data. Digital space is often identified with cyberspace, which is not always justified, as it does not fully reflect the complexity of interactions between people using the Internet and the digital space^[5] (p. 179).

J. Cohen^[6] (pp. 242–243) believes that digital space is “populated” by users experiencing both interconnected spaces. Actions undertaken in one space produce specific consequences in the other. Therefore, distinguishing both spaces and defining their properties requires understanding their interrelationships and interpenetration.

In the school environment and in the educational process, effective communication is crucial, meaning under-

standing, sharing messages, and conveying thoughts. These elements of communication form the basis of interaction and are characterized by feedback, involving the continuous and sustained exchange of messages^[7] (pp. 162–163). Communication is a process that takes place using various means (speech, gestures, writing, e-mail, text messages, instant messaging). The goal of this process is to exchange thoughts, but also to share knowledge, ideas, and information^[8].

Information is therefore becoming an important asset, and its acquisition and transmission are facilitated by the development of new technologies. Young people use new media and information technologies to communicate from an early age. This type of communication has become obvious and natural to them. A young person’s social status is beginning to be reflected in skills related to the efficient use of new media. Digital technologies enable the acquisition of information, and through them, the generation of new knowledge. R. Piotrowska believes that the ability to use modern communication technologies is becoming an opportunity for the development of the entire society^[9] (p. 23). Information literacy is becoming an important factor in the teaching and learning process. A characteristic feature

of such competences is the ease of acquiring them through a multitude of sources that can develop the knowledge of children and young people^[10].

Media and new technologies in the digital educational space are making education begin to be perceived as a requirement of modern times^[11] (p. 57). J. Izdebska even claims that the living space of young people is changing; they are saturated with constantly incoming stimuli, and their living space is characterized by diversity and change^[12] (p. 24). A school that lacks modern educational solutions ceases to be attractive. Digital educational space can support visualization, enabling virtual observation of images, presentations, and symbols.

2.2. Development of Information and Communication Technologies in Education

Today's analysis of social, legal, and ethical aspects confirms the necessity of preparing students to use information and communication technologies, i.e., information and telecommunications equipment, IT infrastructure, software, various IT systems and platforms, and information processing methods. Computer science, as a distinct field of study, was established in the 1960s. At that time, it focused on methods of recording, storing, and processing information using computer equipment, which has now evolved into the primary source of information. Transmitting and receiving information via computer equipment, both stationary and mobile, has introduced radical changes in education, in schools, and among teachers.

The requirements of the current educational standard are an important factor influencing the development of knowledge in the field of information and digitalization among future teachers, because the implementation of a digital educational space requires specialists with appropriate professional competencies in the area of using digital technologies in the educational process. Despite the considerable number of scientific works related to teachers' digital competences, there is no single term that would define their professional competences in the field of information and digital technologies^[13] (p. 51).

Researchers of the issue discussed here use various terms, such as digital competences, ICT competences, digital literacy, or ICT skills. The UNESCO Department of Information Technology uses the term "digital skills" in its studies^[14]

(p. 51). In the same place, it is stated that a teacher's digital competences include the following elements: knowledge, awareness of innovations in pedagogy and teaching, and skills related to the adoption of educational strategies.

The updated version of the European system of digital learning space in the learning process states that digital competences include the critical and conscious use of digital technologies, as well as interaction with them in order to learn, work and function in society^[15] (pp. 9–10).

Digital competences have become a topic of discussion in all current educational theories. Most of them recognize the significant potential of information and communication technologies in personalizing teaching and learning processes through interactive activities. Digital pedagogy can be promoted in two ways: by streamlining teaching processes within digital solutions and by facilitating access to digital educational resources. In many countries, educational policy initially focused on infrastructure development, without training and motivating teachers. Only in the 21st century did information and communication technologies become standard in European countries for teaching, assessment, management, and communication in schools. Computers ultimately became catalysts for innovative activities in education^[16].

The development of information and communication technologies in education involves their increasingly widespread use in school activities. For example, mobile devices can be used to measure various physical quantities (illumination intensity, sound frequency, magnetic induction, temperature, and pressure), as well as to record motion parameters (displacement, speed, distance traveled). One of the most well-known applications for school tasks is the free Phyphox software available on Google Play, which is distinguished by the following features^[17]:

- Has a collection of instructional videos and teaching materials,
- Can work with many mobile device sensors,
- Can export data for further processing in Excel, CSV,
- Can also remotely control experiments conducted during classes,
- Has intuitive interface functionality.

In summary, the introduction of computers, both stationary and mobile, into schools has influenced teaching methods and communication. The development of infor-

mation and communication technologies has enabled the personalization of teaching and increased interactivity of educational processes. In many countries, initially focused on infrastructure development, these technologies are now standard across all aspects of school operations, from teaching to management and communication. The development of digital technologies in education is therefore inextricably linked to the need to develop teacher competencies, modernize teaching methods, and increasingly utilize innovative digital tools and resources in the teaching process.

2.3. Opportunities and Threats of Digitalization in Education

In the area of education of students with special educational needs, the following three areas of influence of modern multimedia devices can be mentioned^[18] (pp. 46–47):

- Information and communication technologies, which provide technical support enabling the student to actively participate in interaction or communication with the environment,
- Information and communication technologies that introduce new dimensions into teaching—they generate a new perspective on the educational process by enabling heterogeneity in forms of teaching and student assessment,
- Information and communication technologies (ICTs) function as important intermediaries in communication. These digital media offer assistive software that meets the needs of students with specific communication challenges.

An important feature of digitalization in education are strategies aimed at fully utilizing the opportunities offered by the development of information and communication technologies and computerization^[19]. According to M. Walczak, the following four stages of development leading education to the state of desired knowledge can be distinguished^[20] (p. 63):

- Computerization of management at the government and local government level related to education,
- Computerization of scientific research projects,
- Individual computerization, which will enable the individual to use information obtained on the Internet to solve various problems,

- Computerization of all levels of education.

Computers can be used alongside traditional methods and teaching aids, particularly when working with young people with learning difficulties. Computer techniques can fulfill various therapeutic functions: cognitive-educational, emotional-motivational, and intercommunicative. Skillfully used, computer methods contribute to improving impaired functions and psychomotor skills. Many such systems have the advantage of stimulating motivation and eliminating anxiety^[21] (p. 533).

According to J. Zielińska, the use of digital technology in learning allows for the improvement of visual analysis and synthesis, perceptiveness, and also improves manipulative skills, stimulates inhibited youth, creating opportunities for better contact with other able-bodied youth. The use of this technology in the educational process enables the creation of conditions for independent work of students, which increases the effectiveness of educational and rehabilitation activities^[22].

Online threats to school youth resulting from digitalization fall into the following areas^[23] (pp. 23–24):

- Psychological threats: escape from the real world to the virtual one, internal compulsion to be online, access to pathological groups,
- Technical threats: computer viruses, threats resulting from data loss due to destruction or theft,
- Medical threats: harmful effects of computer monitor radiation, spinal curvature, obesity,
- Legal threats: copyright threats,
- Social threats: the danger of new social divisions, the problem of digital exclusion, the atomization of youth, problems with privacy protection, obtaining false and incomplete information,
- Information threats resulting from the development of new technologies: excess, omission or discrepancy of information, information noise, problematic value of information, ethical dilemmas,
- Personal threats: too frequent and long use of the Internet,
- Threats to physicality, disturbances of body ecology.

Recently, the term Internet Addiction Syndrome has been used more and more often, which includes the following disorders^[24] (p. 26):

- Physical disorders: posture defects, vision defects,

- nerve damage to the wrist and hand,
- Carpal tunnel syndrome (tight wrist), occurs with prolonged, inappropriate use of a computer keyboard,
- Visual disturbances,
- Chronic shoulder and neck pain, the causes of which are cumulative.

Mental health threats are also common, such as^[24] (p. 27):

- Psychological addictions to the internet: Neuroses, fears,
- Loss of sense of realism,
- Social threats resulting from isolation from the group community,
- Intellectual threats that result from uncritical trust in the capabilities of the computer.

These threats are further compounded by changes in teaching and learning processes. The main threats in this area concern disruptions in the development and functioning of young people's cognitive processes^[25] (p. 23). The primary source of these threats is the rapid growth of various types of information, leading to so-called information overload^[25] (p. 24). The excess of data and the speed of its transmission create a subjective feeling of disorientation, helplessness, threat, or chaos. Such experiences are sometimes referred to as "information stress"^[26] (p. 823).

Contact with dangerous content such as^[27] (p. 139):

- Internet pornography,
- Illegal copying of films and music,
- Electronic gambling,
- Illegal software additions,
- Illegal internet trading,
- Xenophobia,
- Brutal violence,
- Racism.

Every young Internet user is exposed to unwanted contact with content such as^[24] (pp. 28–29):

- Promotional materials (spam),
- Dangerous files (viruses, Trojans),
- Presentation of racism and xenophobia,
- Presentation of violence,
- Content inciting to commit crimes,
- Content encouraging prostitution,
- Content promoting totalitarian systems of states,

- Content containing psycho-manipulative elements,
- Content promoting drugs.

To summarize this section of the study, it can be noted that digitalization strategies adopted by schools generally lead to the full utilization of technology's potential at various stages of educational development, from management, through scientific projects, to individual use. It was also emphasized that computers can support traditional teaching methods, especially when working with struggling students, improving their cognitive and motivational functioning. Technology also plays a significant role in working with students with special educational needs, where it enables active communication, a variety of teaching methods, and supports remedial processes. It was emphasized that digital tools foster independent work and the development of cognitive skills, which increases the effectiveness of education.

A theoretical analysis of the threats associated with digitalization was also conducted, encompassing psychological, technical, medical, legal, social, informational, and personal aspects. Particular emphasis was placed on the phenomenon of Internet Addiction Disorder, encompassing the physical and psychological consequences of excessive internet use.

Another important aspect was the threat of accessing dangerous content, such as pornography, violence, racism, and content promoting drugs and crime. The impact of digitalization on the development of cognitive processes was also considered, highlighting the risk of information overload and the associated stress, as well as the dangers arising from exposure to harmful or manipulative content.

3. Own Research Methodology

3.1. Purpose, Research Problems, Subject and Scope of Research

The main objective of the research included in this article, understood as: a specific goal to be achieved as a result of the conducted research activities, indicating questions that require answers^[28] (p. 47), is to learn and analyze the opinions of students and teachers of secondary schools on the functioning of the digital educational space, as well as to identify factors influencing its effectiveness.

To achieve the main objective, the following specific objectives were adopted:

- Determining the level of use of digital tools in the teaching process,
- Examining the perceived benefits and risks of digitalization of education,
- Comparison of the opinions of both research groups and indication of the relationships between selected variables.

The implementation of the above objectives requires the following questions (research problems), which can be defined as: a question or a set of questions that a specific study is supposed to answer^[29] (p. 32):

- 1) What digital tools and platforms are most frequently used by secondary school students and teachers?
- 2) How do teachers and students assess the functioning of the digital educational space?
- 3) How do teachers perceive the role of digital technologies in the teaching process?
- 4) What are the similarities and differences in the opinions of students and teachers?
- 5) Are there statistically significant relationships between the selected variables?

The research subjects are secondary school teachers and students, and the subject is the digital educational space. The scope of the research covered secondary school teachers and students in the Greater Poland Voivodeship. Respondents' responses were used as variables. The study was conducted in January 2026.

3.2. Research Methods, Techniques and Tools

According to S. Buckler and H. Moore, a method is a system of rules, i.e., a series of cognitive and practical operations, the order of their application and special means and actions directed in advance towards the adopted research goal^[30]. According to M.R. Islam et al., research techniques are practical activities regulated by developed directives, allowing for the acquisition of verified information, opinions, facts^[31]. Research tools are objects used for the technical collection of information, for example observation sheets, survey questionnaires, interview questionnaires^[32].

The main research method used in this study was a survey and statistical method. The survey method is a specific set of stages of research, consistent in the study of a given class of problems^[33]. Its purpose is to collect empirical mate-

rial to solve the identified research problems. The technique used in the study was a survey applied in two variants intended for teachers (14 survey questions) and high school students (13 survey questions), and the tools mainly included survey questionnaires, a computer, and Excel software.

3.3. Characteristics of the Research Group and Research Organization

The research sample was selected based on the size of the study population and the desire to obtain reliable results. These factors contributed to determining the number of study participants using the following formula^[34]:

$$N_{min} = \frac{N_{1/2}}{1 + \frac{4 \cdot d^2 (N-1)}{Z^2}} = \frac{N_{1/2}}{1 + \frac{0.0064(N-1)}{3.8416}}$$

where:

N_{min1} : minimum number of teachers,

N_{min2} : minimum number of students,

N_1 : number of secondary school teachers (1,026)^[35] (p. 49),

N_2 : number of secondary school students (172,500)^[35] (p. 50),

Z : standard value for p significance ($Z = 1.96$, for $p = 0.05$),

d : assumed estimation error ($4\% \geq 0.04$).

$$N_{min1} = \frac{1,026}{1 + \frac{0.0064(1,026-1)}{3.8416}} = \frac{1,026}{2.7076} = 379$$

$$N_{min2} = \frac{172,500}{1 + \frac{0.0064(172,500-1)}{3.8416}} = \frac{172,500}{288.38} = 599$$

A total of 700 teacher questionnaires and 1,000 student questionnaires were sent electronically. 403 completed teacher questionnaires and 794 student questionnaires were returned. 380 teacher questionnaires and 600 student questionnaires were selected for further analysis.

4. Research Results

This chapter presents the results of research conducted to assess the level of digital tool use in education and to explore students' and teachers' opinions on the digital learning space. The analysis included both detailed quantitative and qualitative data, allowing for a more comprehensive understanding of current trends and challenges related to

implementing technology in teaching and learning. Additionally, comparisons between research groups were made and statistical analysis was conducted to obtain reliable and objective conclusions.

The study involved 380 secondary school teachers from the Wielkopolska Voivodeship, the majority of whom were women (64.83%), over 40 years of age (58.67%), with over 10 years of work experience (61.79%), and rarely using digital tools in the work process (51.58%).

The study also included 600 secondary school students, the majority of whom were women/girls (56.83%), from grades 1 to 2. The surveyed students have constant access to new technologies (computer, Internet, smartphone—93.27%) and rarely use digital tools in the learning process (52.04%).

4.1. The Level of Use of Digital Tools by Students and Teachers

The level of proficiency in using digital tools by the surveyed students (very high and high = 82.35%) is significantly higher than that expressed by the surveyed teachers (38.38%)—**Figure 2**.

The availability of digital technologies in the surveyed schools expressed by students (47.8%) also exceeds the assessment of the surveyed teachers (41.82%), although only slightly—**Figure 3**.

The level of school preparation for using digital tools is better perceived by the surveyed teachers (very good and good = 53.44%) than by students (47.23%)—**Figure 4**.

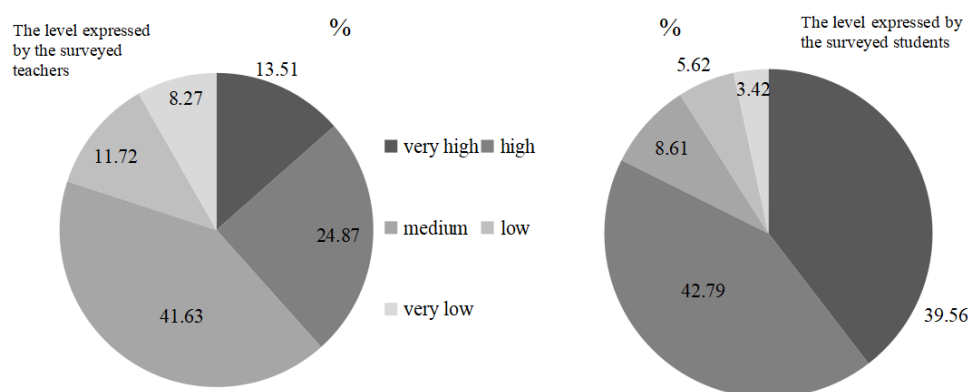


Figure 2. Level of proficiency in using digital tools (Tables A1 and A2).

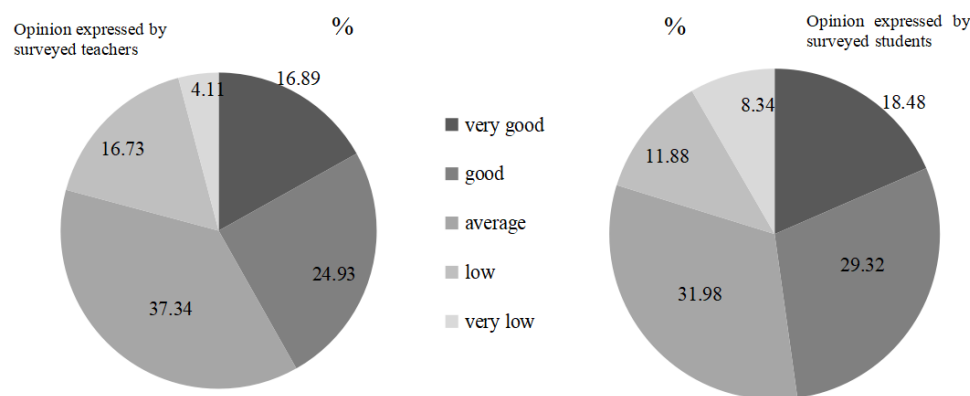


Figure 3. Access to digital technologies at school (Tables A1 and A2).

The digital technologies most frequently used in the surveyed schools include presentation software (teachers—49.62%, students—43.81%), educational websites (teachers—34.87%, students—23.86%), followed by communica-

tion applications (22.67%), according to the surveyed students, and e-learning platforms (7.73%), according to teachers. Artificial intelligence is used the least (teachers—2.85%, students—4.83%)—**Figure 5**.

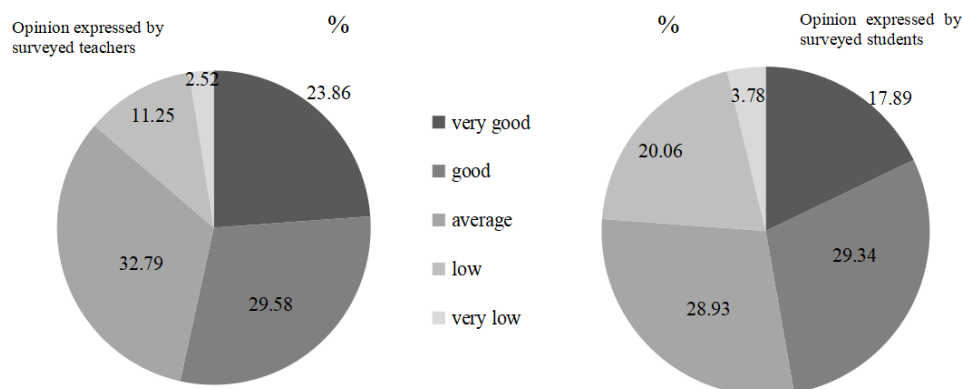


Figure 4. The level of preparation of the school for using digital tools (Tables A1 and A2).

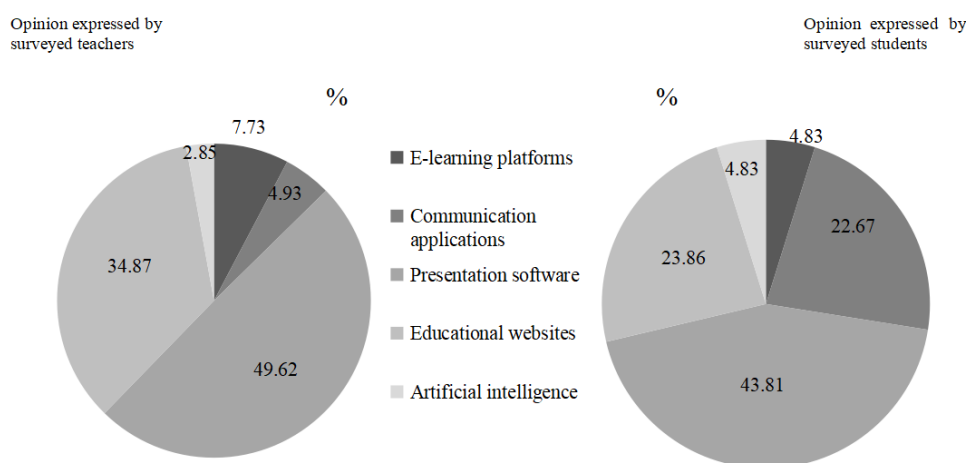


Figure 5. Digital technologies most frequently used in school (Tables A1 and A2).

4.2. Teachers' and Students' Opinions on the Digital Learning Space

Facilitating learning through digital learning spaces notes 77.63% of teachers (definitely yes and rather yes) notice that learning is facilitated through the digital educational space, as do 73.89% of students—**Figure 6**.

The effectiveness of teaching using the digital educational space is noticed by 69.04% of teachers (definitely yes and rather yes), similarly by students—83.83%—**Figure 7**.

The advantages of the digital educational space are noticed by 41.36% of teachers in the form of easy access to educational materials, similarly by students—38.27%—**Figure 8**.

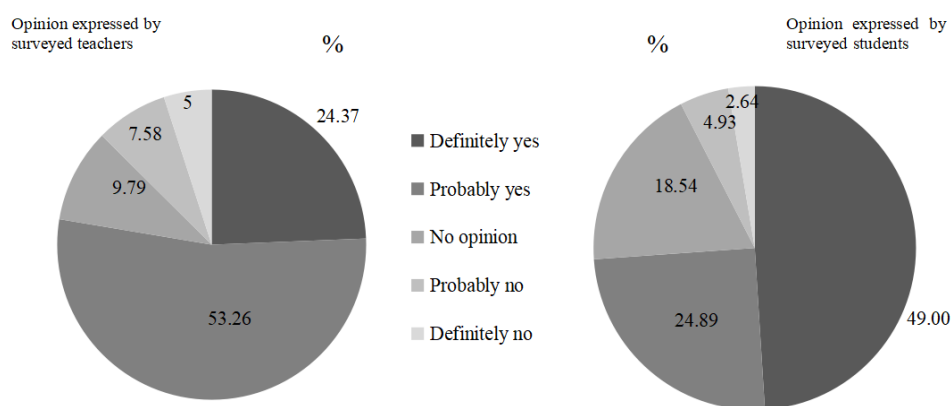


Figure 6. Facilitating learning through a digital learning space (Tables A1 and A2).

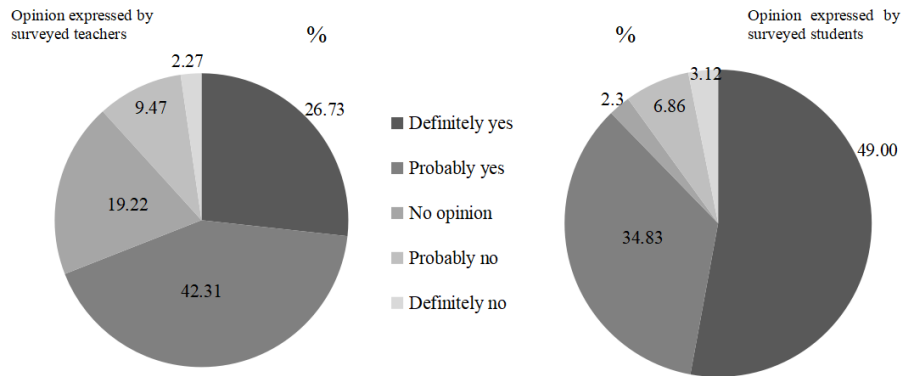


Figure 7. Effective teaching using the digital learning space (Tables A1 and A2).

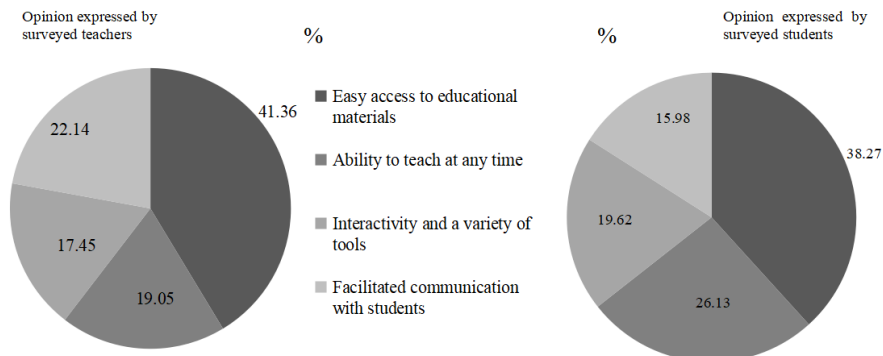


Figure 8. Advantages of a digital learning space (Tables A1 and A2).

The ability to teach and learn at any time is recognized by 26.13% of surveyed students and slightly fewer by teachers (19.05%). Teachers are more appreciative of the ease of communication with students (22.14%, students—15.98%).

The biggest challenges or threats in using the digital educational space, according to the surveyed teachers, are: chaos when working with students (54.94%), and similarly, according to the surveyed students: chaos while learning (52.38%)—**Figure 9**.

A lack of direct contact with teachers (and students)

was noted by 31.78% of surveyed teachers and 37.83% of surveyed students. Only about 11% of respondents reported problems with internet access.

The most helpful changes or improvements in the digital educational space, according to the surveyed teachers, concern: monitoring and analysis of learning progress (39.68%) and the possibility of creating interactive lessons (31.26%), and according to students: the possibility of creating interactive lessons (35.89%) and the use of intuitive educational platforms (31.96%)—**Figure 10**.

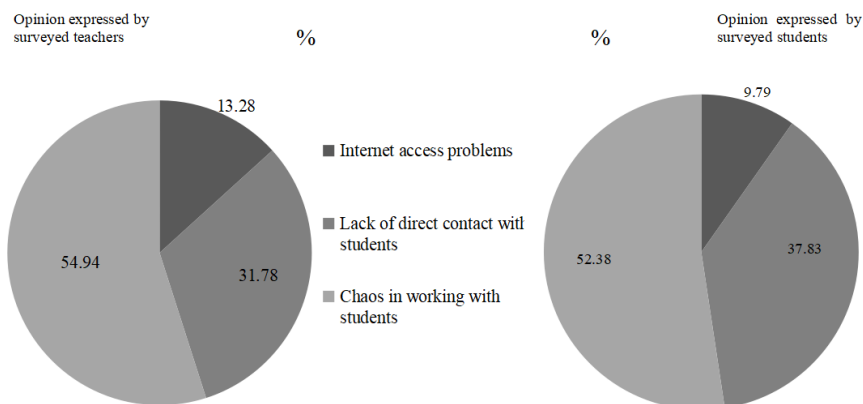


Figure 9. Challenges or threats in using the digital learning space (Tables A1 and A2).

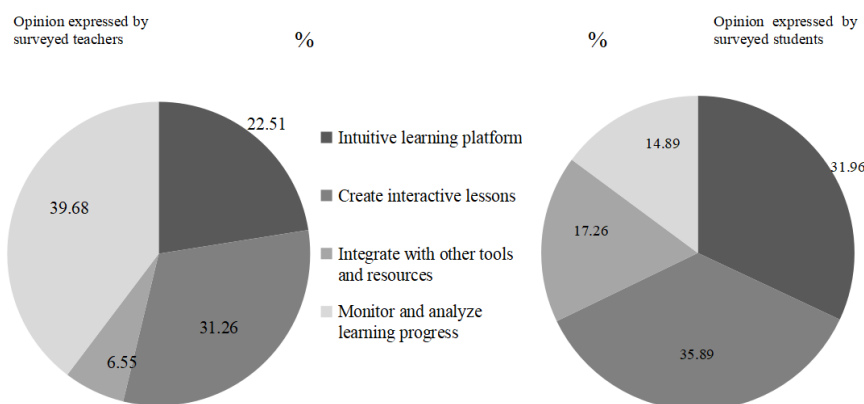


Figure 10. The most helpful changes or improvements in the digital learning space (Tables A1 and A2).

The least popular changes are those related to integration with other tools and resources—around 11%.

4.3. Statistical Analysis of Research Results

The assumed significance level was: $\alpha = 0.05$ ^[36] (p. 55). Theoretical numbers were determined using the formula by A. Almudevar^[37]:

$$\hat{n}_{ij} = \frac{n_i \cdot n_j}{n},$$

where: n_i, n_j —marginal numbers.

The test statistic χ^2 has the form^[38]:

$$\chi^2 = \sum_{i=1}^k \sum_{j=1}^r \frac{(n_{ij} - \hat{n}_{ij})^2}{\hat{n}_{ij}}$$

The Student's t -test was used to test the significance of differences. The value of the statistic was calculated according to the following formula^[37] (p. 66):

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{n_1 S_1^2 + n_2 S_2^2}{n_1 + n_2 - 2} \cdot \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

where:

S_1^2, S_2^2 —sample variances,

$(\bar{x}_1 - \bar{x}_2)$ —difference in mean values, and in the denominator: standard error of this difference,

n_i, n_j —sample sizes, with $(n_1 + n_2 - 2)$ degrees of freedom.

For non-homogeneous variances the test has the following form^[37] (p. 65):

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}, \text{ by } \left(\frac{1}{2} + \frac{S_1^2 \cdot S_2^2}{S_1^2 + S_2^2} \right) \cdot (n_1 + n_2 - 2)$$

degrees of freedom.

To investigate the interdependence of features X and Y , Pearson's linear correlation coefficient can be calculated according to the formula^[31] (p. 275):

$$r(X, Y) = \frac{\sum_{t=1}^n (x_t - \bar{x}) \cdot (y_t - \bar{y})}{\sqrt{\sum_{t=1}^n (x_t - \bar{x})^2 \cdot \sum_{t=1}^n (y_t - \bar{y})^2}}$$

where:

n —feature values,

x_t and $y_t = 1, 2, \dots, n$,

$\bar{x}$ and $\bar{y}$ —arithmetic mean values of features X and Y .

The frequency distribution for the assessment of the functioning of the digital educational space by gender, age and work experience of the surveyed teachers is presented in **Table 1**, actual numbers—**Table 2** and theoretical numbers—**Table 3**.

Table 1. Frequency distribution for the assessment of the functioning of the digital educational space by gender, age and work experience of the surveyed teachers (Table A1).

Functioning of the Digital Educational Space	Gender				Age				Length of Service			
	Man	%	Woman	%	<40	%	>40	%	<10	%	>10	%
very good	38	28.36	53	21.41	42	26.75	43	19.25	39	26.9	51	21.64
good	56	41.79	83	33.71	71	45.23	88	39.63	71	48.96	93	39.7
average	32	23.88	66	26.87	36	22.93	62	27.67	30	20.69	54	22.92
weak	6	4.48	30	12.32	5	3.18	18	8.07	3	2.07	22	9.17
very weak	2	1.49	14	5.69	3	1.91	12	5.38	2	1.38	15	6.57

Table 1. Cont.

Functioning of the Digital Educational Space	Gender				Age				Length of Service			
	Man	%	Woman	%	<40	%	>40	%	<10	%	>10	%
Total:	134	100	246	100	157	100	223	100	145	100	235	100
Together:		380				380					380	

Table 2. Actual numbers (Table 1).

Functioning of the Digital Educational Space	Gender			Age			Length of Service		
	Man	Woman	Sum	<40	>40	Sum	<10	>10	Sum
very good	38	53	91	42	43	85	39	51	90
good	56	83	139	71	88	159	71	93	164
average	32	66	98	36	62	98	30	54	84
weak	6	30	36	5	18	23	3	22	25
very weak	2	14	16	3	12	15	2	15	17
Total:	134	246	380	157	223	380	145	235	380

Table 3. Theoretical numbers (Table 2).

Functioning of the Digital Educational Space	Gender		Age		Length of Service	
	Man	Woman	<40	>40	<10	>10
very good	32	59	35	50	34	56
good	49	90	66	94	63	102
average	35	64	40	57	32	52
weak	13	24	9	13	9	15
very weak	6	10	6	9	7	11
Total:	134	246	157	223	145	235

The functioning of the digital educational space in relation to the gender of the surveyed teachers—shows a statistically significant relationship, because: $p = 0.0122 < 0.05$, at $\chi^2 = 12.82$.

The functioning of the digital educational space in relation to the age of the surveyed teachers—shows a statistically significant relationship, because: $p = 0.0362 < 0.05$, at $\chi^2 = 10.27$.

The functioning of the digital educational space in relation to the work experience of the surveyed teachers—shows a strongly statistically significant relationship, because: $p = 0.0041 < 0.01$, at $\chi^2 = 15.29$.

The functioning of the digital educational space in relation to gender, age and work experience of the surveyed teachers—was rated highest by men (very good and good, respectively: 28.36% and 41.79%), by people up to 40 years of age (respectively: 26.75% and 45.23%) and by people with work experience of less than 10 years (respectively: 26.9% and 48.96%)—Figure 11.

The frequency distribution for the assessment of the functioning of the digital educational space by gender and age (grade) of the surveyed students is presented in Table 4, actual numbers—Table 5 and theoretical numbers—Table 6.

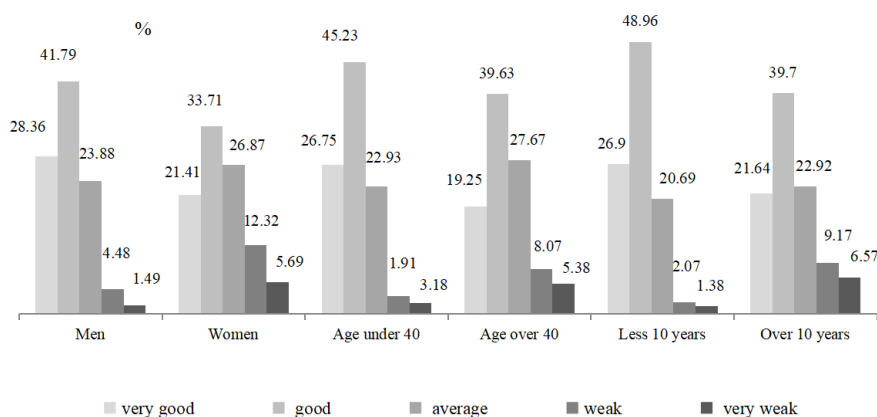


Figure 11. The functioning of the digital educational space in relation (Table 1).

Table 4. Frequency distribution for the assessment of the functioning of the digital educational space by gender, age (grade) of the surveyed students (Table A1).

Functioning of the Digital Educational Space	Gender				Class (Age)			
	Boys	%	Girls	%	1–2	%	Above 2	%
very good	137	52.64	158	46.23	139	41.37	129	49.26
good	74	28.69	75	21.89	77	22.79	72	27.37
average	35	13.48	78	22.97	86	25.48	43	16.36
weak	8	3.18	17	5.12	22	6.42	11	4.12
very weak	5	2.01	13	3.79	13	3.94	8	2.89
Total:	259	100	341	100	337	100	263	100

Table 5. Actual numbers (Table 4).

Functioning of the Digital Educational Space	Gender			Class (Age)		
	Boys	Girls	Sum	1–2	Above 2	Sum
very good	137	158	294	139	129	269
good	74	75	149	77	72	149
average	35	78	113	86	43	129
weak	8	17	26	22	11	32
very weak	5	13	18	13	8	21
Ogółem:	259	341	600	337	263	600

Table 6. Theoretical numbers (Table 5).

Functioning of the Digital Educational Space	Gender		Class (Age)	
	Man	Woman	1–2	Above 2
very good	127	167	151	119
Good	64	85	84	65
medium	49	64	72	56
weak	11	15	18	14
very weak	8	10	12	9
Total:	259	341	337	263

The functioning of the digital educational space in relation to the gender of the surveyed students—shows a strongly statistically significant relationship, because: $p = 0.0078 < 0.01$, at $\chi^2 = 13.84$.

The functioning of the digital educational space in relation to the class (age) of the surveyed students—shows a statistically significant relationship, because: $p = 0.0273 < 0.05$, at $\chi^2 = 10.93$.

0.05, at $\chi^2 = 10.93$.

The functioning of the digital educational space in relation to gender and class (age) of the surveyed students was rated highest by boys (very good and good, respectively: 52.64% and 28.69%), by young people from the 2nd grade and above (49.26% and 27.37%, respectively)—**Figure 12**.

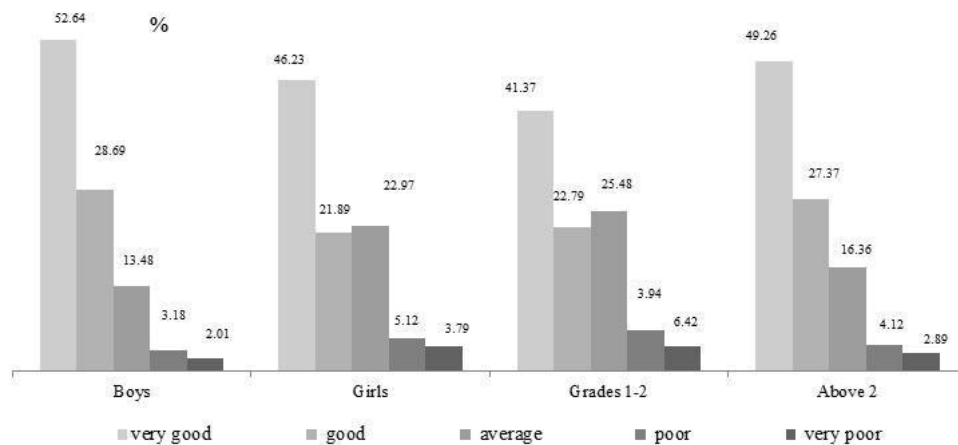


Figure 12. The functioning of the digital educational space in relation (Table 4).

The statistical analysis of the relationship between the level of proficiency in using digital tools expressed by teachers and the effectiveness of teaching resulting from the digital educational space available at school was assessed using the Pearson correlation coefficient:

$$R_{xy} = \frac{\sum_{i=1}^n [(x_i - \bar{x}) \cdot (y_i - \bar{y})]}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \cdot \sum_{i=1}^n (y_i - \bar{y})^2}} = \frac{4,955}{12,162} = 0.4074$$

The correlation coefficient $R_{xy} = 0.4074$ indicates a moderate positive correlation between teachers' level of proficiency in using digital tools and the effectiveness of teaching resulting from the school's digital learning space. This relationship is statistically highly significant: $p < 0.01$, at $\chi^2 = 129.45$.

A similar analysis conducted for students shows:

$$R_{xy} = \frac{\sum_{i=1}^n [(x_i - \bar{x}) \cdot (y_i - \bar{y})]}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \cdot \sum_{i=1}^n (y_i - \bar{y})^2}} = \frac{59,154}{63,395} = 0.9331.$$

The correlation coefficient $R_{xy} = 0.9331$ indicates a strong positive correlation between students' level of proficiency in using digital tools and the effectiveness of teaching resulting from the school's digital learning space. This relationship is statistically significant: $p < 0.01$, at $\chi^2 = 39.15$.

5. Discussion of Research Results

The obtained research results indicate that students from the surveyed secondary schools have a comparable level of proficiency in using digital tools to the surveyed teachers, although in the study they are significantly more confident in this area. This result is consistent with the findings of G.P.D. Ingram, who indicated that young people function in the digital environment more naturally than older generations, thus adapting new technologies more quickly^[39].

M. Zielińska shares a similar view, noting that the teaching model is shifting from knowledge transfer to knowledge construction and collaboration^[40]. Digital technologies are no longer merely an add-on, but constitute a structure that organises the teaching process^[41]. Research has also shown that the most frequently used digital tools in schools are presentation software and educational websites. Artificial intelligence is used to a limited extent. D. Morańska and M. Ciesielka express a similar view, although, in their opinion,

AI is gaining increasing importance^[42] (p. 18). These results also correspond with the observations of J. Cheng et al. who points out that schools still rely primarily on basic ICT tools, while more advanced solutions, such as artificial intelligence or learning analytics, remain at the pilot stage of implementation^[43].

L. Pokrzycka argues that the theoretical foundations of digital education are insufficient and supports her findings with examples from the practical implementation of e-learning, combining theoretical and empirical reflection^[44] (pp. 75–76, 188–189).

Both teachers and students surveyed assessed the impact of digital educational environments on the learning process positively, recognising that digital technologies facilitate learning. Similarly, the effectiveness of teaching using digital tools was confirmed by the vast majority. M. Smith and J. Traxler make a similar observation, providing a multifaceted analysis of education in a digital environment^[45] (p. 94). These results are also consistent with the findings of S. Connolly, who found that digital technologies increase the attractiveness of the teaching process, enhance student motivation, and promote individualised learning^[46].

The most important advantage of digital educational environments, as indicated by both groups of respondents, was the ease of access to educational materials. Students were more likely than teachers to value the ability to learn at their own pace, while teachers more frequently pointed to improved communication with students. E. Brooks, who characterised modern learning models and the design of learning environments, presents a similar perspective on digital educational environments^[47] (pp. 69–70, 218–219). J.E. Hughes and Roblyer draws similar conclusions, emphasising that flexible access to knowledge and the possibility of synchronous and asynchronous communication are among the most significant benefits of the digitalisation of education^[48]. The greatest threats to the functioning of digital educational environments proved to be disorganisation in work and learning, as well as the lack of direct contact between participants in the teaching process. These findings confirm the conclusions of J. Cheng, who notes that an excessive number of tools and sources of information may lead to information overload and reduced teaching effectiveness^[43] (pp. 145–146). N. Selwyn, who critically analyses technology in education^[49], also highlights these issues.

Statistical analysis revealed significant correlations between the assessment of the functioning of the digital educational space and the gender, age, and experience of the surveyed teachers, as well as the gender and grade of the students. Higher ratings were more often expressed by men, younger teachers, and teachers with shorter experience. In the case of students, more positive assessments were expressed by boys and students in older grades. These conclusions are consistent with J. Ross research, which indicated that younger generations of teachers and students are more open to technological innovations and adapt more easily to changes in the educational environment^[50].

6. Conclusions

The research conducted allowed for a detailed understanding of the functioning of digital learning spaces in the surveyed secondary schools in the Wielkopolska region and an assessment of its importance for the teaching process. The results confirm that digital technologies currently play a crucial role in both teachers' work and students' daily lives. Modern schools increasingly utilize digital solutions not only as an additional tool supporting teaching, but also as an integral element of the educational process.

Research has shown that students demonstrate higher, or at least comparable, levels of digital competence than teachers. This is primarily due to the fact that young people grow up in a highly technological environment and use mobile devices, the internet, and digital applications from an early age. For many students, new technologies constitute a natural functioning environment, which is why they adapt new solutions more easily and learn to use new tools more quickly. Teachers, especially older teachers and those with longer experience, are more likely to be cautious about these technologies and prefer traditional forms of teaching.

A significant finding from the research is that both teachers and students positively assess the impact of digital learning spaces on the teaching and learning process. These technologies enable faster access to knowledge, facilitate communication, increase the attractiveness of classes, and allow for better adaptation of teaching materials to individual student needs. The use of educational platforms, multimedia presentations, and instant messaging applications allows for more flexible organization of the teaching process, both

in-person and remotely.

The research also reveals the most frequently used digital tools, such as presentation software, electronic journals, educational websites, and communication apps. Artificial intelligence technologies are used much less frequently. This may indicate schools' insufficient preparation for implementing more advanced solutions, a lack of appropriate training, or financial constraints related to purchasing specialized software.

Based on the conducted analyses, one of the most important advantages of the digital educational space is the ability to easily and quickly access teaching materials. Students can access educational resources anywhere, anytime, which promotes independent learning, developing interests, and consolidating acquired knowledge. Furthermore, teachers can deliver materials in various formats—text, graphics, video, or interactive—which increases the attractiveness of classes and facilitates the understanding of more challenging concepts.

However, the research also revealed significant problems and threats related to the functioning of the digital educational space. One of the most frequently cited problems was information chaos resulting from an overabundance of content, platforms, and communication channels. Both teachers and students noted that too many digital tools can lead to work disorganization, concentration problems, and difficulties with time management. Another significant threat is the limitation of direct interpersonal contact, which plays a crucial role in the educational process, building relationships, and developing social skills.

In light of the research's stated goal, it should be noted that it was achieved. The study determined the level of digital tool use by teachers and students, identified the main benefits and risks associated with the functioning of the digital educational space, and identified factors influencing the assessment of technology's effectiveness in education. The research questions regarding the level of digital competence of the respondents, their use of technology, and the relationship between their assessment of the digital educational space and the socio-demographic characteristics of the respondents were also addressed.

The research findings can provide a basis for formulating practical recommendations for schools and educational institutions. It seems necessary to increase the number of

training sessions for teachers in the use of modern technologies and the development of digital competencies. It is also crucial to ensure appropriate technical infrastructure, access to modern tools and software, and organizational support for teachers implementing new solutions. It is also worthwhile to strive to reduce the number of platforms and applications used, so that the communication and management of teaching materials is more transparent and structured.

In summary, the digital learning space is an important element of the modern educational system and has significant development potential. However, for it to be used effectively, it is necessary to maintain a balance between modern technologies and traditional teaching methods. Technologies should support the learning process, but they cannot completely replace direct contact between teacher and student. Only the conscious and responsible use of digital tools can improve the quality of education and increase the effectiveness of the teaching process.

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Institutional Review Board Statement

The study was conducted using anonymous surveys and did not require formal consent from the Ethics Committee.

Informed Consent Statement

Informed consent was obtained from all individuals participating in the study.

Data Availability Statement

All data not covered by the GDPR system has been included in the article.

Conflicts of Interest

The author declares no conflict of interest.

AI Use Statement

The author declares that no artificial intelligence (AI) tools were used in the preparation of this manuscript.

Appendix A

Table A1. Survey for teachers.

LP.	Questions	Variables	Answers	
			Number (380)	%
1.	Gender:	man	134	35.17
		woman	246	64.83
2.	Age:	up to 40 years old	157	41.33
		over 40 years old	223	58.67
4.	Length of service	up to 10 years	145	38.21
		over 10 years	235	61.79
5.	How often do you use digital tools in your work process?	often	184	48.42
		rarely	196	51.58
6.	How do you rate your level of proficiency in using digital tools?	very high	51	13.51
		tall	95	24.87
		mediocre	158	41.63
		short	45	11.72
		very low	31	8.27
7.	How do you assess the availability of digital technologies at school?	very good	64	16.89
		all right	94	24.93
		mean	142	37.34
		low	64	16.73
		very low	16	4.11

Table A1. Cont.

LP.	Questions	Variables	Answers	
			Number (380)	%
8.	Do you think that the digital educational space makes learning easier?	definitely yes	93	24.37
		rather like this	202	53.26
		I have no opinion	37	9.79
		I don't think so	29	7.58
		definitely not	19	5.0
9.	How do you assess the level of preparation of the school for using digital tools?	very good	91	23.86
		all right	111	29.58
		on average	125	32.79
		weakly	43	11.25
		very weakly	10	2.52
10.	Does the digital learning space influence the effectiveness of teaching?	definitely yes	102	26.73
		rather like this	160	42.31
		I have no opinion	73	19.22
		I don't think so	36	9.47
		definitely not	9	2.27
11.	What digital technologies do you use most often in education?	learning platforms	29	7.73
		communication applications	19	4.93
		presentation creation programs	188	49.62
		educational services	133	34.87
		artificial intelligence	11	2.85
12.	What do you think are the main advantages of the digital educational space?	ease of access to educational materials	158	41.36
		the ability to teach at any time	72	19.05
		interactivity and variety of tools	66	17.45
		facilitating communication with students	84	22.14
13.	What challenges or threats do you see in using the digital educational space?	problems with internet access	50	13.28
		no direct contact with students	121	31.78
		chaos in working with students	209	54.94
14.	What changes or improvements in the digital learning space would be most helpful to you?	intuitive educational platforms	86	22.51
		the ability to create interactive lessons	119	31.26
		integration with other tools and resources	25	6.55
		monitoring and analysis of learning progress	150	39.68

Table A2. Survey for students.

LP.	Questions	Variables	Answers	
			Number (600)	%
1.	Gender:	man	259	43.17
		woman	341	56.83
2.	Class:	to 1 to 2	337	56.25
		over 2	263	43.75
3.	Do you have constant access to new technologies (computer, Internet, smartphone)?	yes	560	93.27
		no	40	6.73
4.	How often do you use digital tools in your learning process?	often	288	47.96
		rarely	312	52.04
5.	How would you rate your level of proficiency in using digital tools?	very high	237	39.56
		tall	256	42.79
		mediocre	52	8.61
		short	34	5.62
		very low	21	3.42
6.	How do you assess the availability of digital technologies at school?	very good	111	18.48
		all right	176	29.32
		mean	192	31.98
		low	71	11.88
		very low	50	8.34

Table A2. Cont.

LP.	Questions	Variables	Answers	
			Number (600)	%
7.	Do you think the digital learning space makes learning easier?	definitely yes	294	49.0
		rather like this	149	24.89
		I have no opinion	111	18.54
		I don't think so	30	4.93
		definitely not	16	2.64
8.	How do you assess the school's level of preparation for using digital tools?	very good	107	17.89
		all right	176	29.34
		on average	174	28.93
		weakly	120	20.06
		very weakly	23	3.78
9.	Does the digital educational space influence the effectiveness of learning?	definitely yes	317	52.89
		rather like this	209	34.83
		I have no opinion	14	2.3
		I don't think so	41	6.86
		definitely not	19	3.12
10.	What digital technologies do you use most often at school?	learning platforms	29	4.83
		communication applications	136	22.67
		presentation creation programs	263	43.81
		educational services	143	23.86
		artificial intelligence	29	4.83
11.	What are the main advantages of a digital learning space?	ease of access to educational materials	230	38.27
		the ability to learn at any time	156	26.13
		interactivity and variety of tools	118	19.62
12.	What challenges or threats do you see in using the digital learning space?	facilitating communication with the teacher	96	15.98
		problems with internet access	59	9.79
		no direct contact with the teacher	227	37.83
		chaos while studying	314	52.38
13.	What changes or improvements in the digital learning space would be most helpful?	adaptation to individual needs	192	31.96
		interactivity and engaging materials	215	35.89
		support in the field of new technologies	104	17.26
		shorter and more concise educational materials	89	14.89

References

- [1] Janc, K., 2019. Digital space and the Internet as a subject of interest in geographical research. *Geographical Review*. 91(2), 21–37.
- [2] Dodge, M., Kitchin, R., 2004. Flying through Code/Space: The Real Virtuality of Air Travel. *Environment and Planning A*. 36(2), 195–211.
- [3] Graham, M., Zook, M., Boulton, A., 2013. Augmented reality in urban places: Contested content and the duplicity of code. *Transactions of the Institute of British Geographers*. 38(3), 464–479.
- [4] Benkler, Y., 2008. *The Wealth of Networks: How Social Production Transforms Markets and Freedom*. Yale University Press: New Haven, CT, USA.
- [5] Graham, M., 2013. Geography/Internet: Ethereal Alternate Dimensions of Cyberspace or Grounded Augmented Realities? *The Geographical Journal*. 179(2), 177–182.
- [6] Cohen, J.E., 2007. *Cyberspace as/and Space*. Columbia Law Review. 107, 210–256.
- [7] Perwana Harahap, W.S., Ardi, H., 2023. Teachers' Communicative Competence. In *Proceedings of the International Conference on English Language and Teaching (ICOELT 2022)*, Padang, Indonesia, 26–27 October 2022; pp. 276–285.
- [8] Kapur, R., 2021. The Types of Communication. *Multi-disciplinary International Journal*. 6.
- [9] Piotrowska, R., 2011. *Information Education in Polish Schools*, 3rd ed. WSBP: Warsaw, Poland. (in Polish)
- [10] Kowalczyk, A., Nowak, P., 2022. *Digital Educational Space in the Era of the COVID-19 Pandemic*, 3rd ed. University of Warsaw: Warsaw, Poland. (in Polish)
- [11] Frania, M., 2013. *Media Education and Advertising*, 3rd ed. University of Silesia: Katowice, Poland. (in Polish)
- [12] Izdebska, J., 2007. *The Child in the World of Electronic Media*, 3rd ed. Trans Humana: Białystok, Poland. (in Polish)
- [13] Yuzyk, M., Vysochan, L., Saenko, J., 2020. Preparing future teachers for work in the digital educational space. *Zeszyty Naukowe WST*. 12, 47–58.
- [14] Karpati, A., 2011. *Digital Literacy in Education*. Policy Brief. UNESCO Institute: Paris, France.

- [15] Council of the European Union, 2018. Council Recommendation of 22 May 2018 on Key Competences for Lifelong Learning. Council of the European Union: Brussels, Belgium.
- [16] Push, T., 2022. Information and Communication Technologies in Education. SCSVMV University: Kanchipur, India.
- [17] Pun, J.K.H., Curle, S., Yuksel, D. (Eds.), 2022. The Use of Technology in English Medium Education. Springer Nature Switzerland: Cham, Switzerland.
- [18] Çeçelek, G., 2021. The use of modern information technologies in education. *Culture and Education*. 2(20), 43–55.
- [19] Ministry of Education of Montenegro, 2022. Education System Digitalization Strategy with the Action Plan for 2022 and 2023. UNICEF Institute: Podgorica, Montenegro.
- [20] Walczak, M., 2012. Fundamental cultural changes as a result of medialization of all areas of life. *Medical Libraries Forum*. 1.
- [21] Hartman, M.C., Smolen, E.R., Powell, B., 2023. Curriculum and Instruction for Deaf and Hard of Hearing Students: Evidence from the Past—Considerations for the Future. *Education Sciences*. 13(6), 533.
- [22] Zieliński, S., 2017. The role of digital media in the education of pupils and students with disabilities. *Media Science Quarterly*. 3.
- [23] Szymańska, M., 2008. The role of the Internet in the education of children and youth. *Care and Education Problems*. 6, 22–25.
- [24] Furmanek, W., 2022. Threats Resulting from the Development of Information Technologies, 3rd ed. URz: Rzeszów, Poland. pp. 20–48.
- [25] Liu, X., 2023. The Influence of the Internet on Children's Education. *Lecture Notes in Education Psychology and Public Media*. 34, 122–126.
- [26] Almakrob, A.Y., Alduais, A., 2026. Digital Stress: Insights from Bibliometric, Scientometric, Meta-Analytic and Thematic Analyses. *Healthcare*. 14(6), 823.
- [27] Jakubik, A., 2022. Internet addiction syndrome. *Studies Psychologica*. 3, 133–142.
- [28] Nowosielski, S., 2024. Goals in Scientific Research in the Field of Management. UE: Wrocław, Poland. (in Polish)
- [29] Jeszka, A.M., 2013. Research problems and hypotheses in management sciences. *Organization and Management*. 5, 31–39.
- [30] Buckler, S., Moore, H., 2023. Essentials of Research Methods in Education. SAGE Publications: Thousand Oaks, CA, USA.
- [31] Islam, M.R., Khan, N.A., Baikady, R. (Eds.), 2022. Principles of Social Research Methodology. Springer: Singapore.
- [32] Shields, S., Schartner, A., Curtis, W., et al., 2025. Research and Education: An Introduction to Methods, Approaches and Processes, 2nd ed. Routledge: London, UK.
- [33] Katila, S., Meriläinen, S., Bell, E., 2023. Handbook of Feminist Research Methodologies in Management and Organization Studies. Edward Elgar Publishing: Cheltenham, UK.
- [34] Zumitzavan, V., 2026. Sample Selection Methods. In *Social Science Methodologies for Management Research*. Springer: Singapore. pp. 79–95.
- [35] Central Statistical Office, 2019. Diagnosis of the Situation on the Education Market in the Greater Poland Voivodeship. GUS: Poznań, Poland.
- [36] Wątroba, J., 2002. Introduction to the Analysis of Variance. StatSoft Polska: Kraków, Poland. pp. 50–61. (in Polish)
- [37] Almudevar, A., 2022. Theory of Statistical Inference. Chapman & Hall/CRC: Boca Raton, FL, USA.
- [38] Gordon, R.A., 2023. Applied Statistics for the Social and Health Sciences, 2nd ed. Routledge: New York, NY, USA.
- [39] Ingram, G.P.D., 2023. Adolescent Use of New Media and Internet Technologies: Debating Risks and Opportunities in the Digital Age. Routledge: London, UK.
- [40] Zielińska, M., 2022. Digital Education in Poland—Challenges and Opportunities. *Dialogue: Warsaw, Poland*. (in Polish)
- [41] Wiśniewska, K., 2023. Digital Technologies and the Transformation of Education: New Challenges and Perspectives. PWN: Warsaw, Poland. (in Polish)
- [42] Morańska, D., Ciesielka, M., 2024. Supporting the Development of Digital Skills in Students and Teachers. ODN: Warsaw, Poland. (in Polish)
- [43] Cheng, J., Han, W., Zhou, Q., et al., 2024. Handbook of Teaching Competency Development in Higher Education. Springer: Singapore.
- [44] Pokrzycka, L., 2023. E-Learning in the Practice of Teaching Doctoral Students. *European Journal of Open, Distance and E-Learning*. 25(1), 117–128.
- [45] Smith, M., Traxler, J., 2022. Digital Learning in Higher Education. Edward Elgar Publishing: Cheltenham, UK.
- [46] Connolly, S., 2022. The Changing Role of Media in the English Curriculum: Returning to Nowhere. Routledge: London, UK.
- [47] Brooks, E., Dau, S., Selander, S., 2022. Digital Learning and Collaborative Practices: Lessons from Inclusive and Empowering Participation with Emerging Technologies. Routledge: London, UK.
- [48] Hughes, J.E., Roblyer, M.D., 2022. Integrating Educational Technology into Teaching: Transforming Learning across Disciplines, 9th ed. Pearson: New York, NY, USA.
- [49] Selwyn, N., 2022. Education and Technology: Key Issues and Debates. Bloomsbury: London, UK.
- [50] Ross, J., 2023. Digital Futures for Learning: Speculative Methods and Pedagogies. Routledge: London, UK.