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Article

Digital education in Germany: Policies, teacher perspectives, and challenges in a post-pandemic world

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Abstract: This article intends to conduct a theoretical examination of education and technology public policies proposed for the German school system, under a post-pandemic context in which governments around the world have strengthened their pedagogical initiatives in digital technologies in the school environment. The results presented here are part of the research "Post-pandemic education: understanding of analogic education and digital education from the perspective of educational institutions and teachers in Brazil and Germany", carried out between 2023 and 2024. As a method, we conducted extensive documentary research that analyzed within the context of technology-mediated educational policies in Germany, in a global context. We sought to relate these policies to a possible change in school education that can also reposition teacher training in the country. In the German context, the article describes the education system, digital education policies and the challenges in their implementation. The results show important avenues for changes in teacher training for the use of technology and the need for additional research to assess the impact of digital education.

Keywords: digital education; digital technologies; teacher training; educational policies; Germany; post-pandemic; artificial intelligence; digital skills

1. Introduction

This article intends to conduct a theoretical examination of education and technology public policies proposed for the German school system, under a post-pandemic context in which governments around the world have strengthened their pedagogical initiatives in digital technologies in the school environment. The results are part of the research "Post-pandemic education: understanding of analogic education and digital education from the perspective of educational institutions and teachers in Brazil and Germany", whose main objective is to analyze how teachers and educational institutions mobilize and position themselves to expand digital education practices. This study was supported by CAPES (Brazil), CNPq (Brazil) and FAPEMIG (Brazil).

This article addresses the theoretical-conceptual dimensions of the German educational system and public policies for digital education in Germany, based on the results brought by [1]. To do so, we started from the following research questions.

- How does the German educational model work, what are the relationships with digital technologies?
- What are the main German education policies aimed at the digitalisation of its education system?
- What are the main results achieved so far?

We consider that the post-Covid-19 pandemic context has amplified debates on the uses of digital technologies in the educational process around the world [2–5], however, this debate cannot be attributed to the pandemic, since it has been held for many decades worldwide [6–9]. This intensification of the debate is related to an empirical dynamic, in which for the first time the use of digital technologies has become mandatory to meet educational demands in the short and medium term on a global scale [10].

On the one hand, there is the consolidation of movements to expand the use of digital technologies in schools, notably through educational policies developed within the scope of government secretariats, built with little teacher participation, increasing the risk of not obtaining the expected result [4,11].

It is also observed, in this same line of institutional action, the intensive performance of companies called "big techs", notably Google, Meta, Amazon, and Apple, demonstrate a hegemony in the global market that resonates as monopoly practices, as identified by Komljenovic [12]. In addition, all the companies mentioned have their headquarters in the United States [13] which indicates an intensified movement of technological actions in the educational area, such as the provision of online applications, data hosting and storage spaces, virtual learning environments and numerous other administrative and educational software as observed by [14].

The apparent discourse of inevitability together with the monopoly of these companies can direct entire educational systems of a country to adopt practices whose implications for students and teachers are unknown and uncertain. Due to the non-transparent practices of technological access proposed by these companies, discursive movements are observed that are more economical than pedagogical and ethical movements in data processing [15,16].

This article analyzed the theoretical movements around educational policies aimed at educational digitalization in the German school system, in search of understandings that would allow us to understand the place that the teacher comes to occupy.

2. Methods

As a method, we conducted extensive documentary research that analyzed within the context of technology-mediated educational policies in Germany, in a global context.

Initially, we did a broad bibliographic review of the German literature on the subject, while analyzing European documents, such as those from UNESCO and the European Community, to understand the place that Germany occupies in digital technology policies in the school system.

We then proceed to a documentary analysis of national policies for digitization and inclusion of digital technologies. In addition to the discussion and materials at the national level, we sought documentation from the three most populous regions of Germany: North Rhine-Westphalia (18.1 million); Bayern (13.4 million) and Baden-Württemberg (11.3 million). Population data are from the demographic portal [17].

In the German educational model, states are free to organize their educational systems, which justifies the need to know the policies on digital technologies in regional educational systems.

In addition, the choice was made due to the possibility that the public policies implemented there have impacts on a greater number of students and teachers, since these three regions are equivalent to about 50% of the German population.

Theoretical discussion: education and digital technologies in the international historical context

The importance of discussions about digital technologies in education is intrinsically linked to the very relevance of school education in modern capitalist society. To understand this relationship, it is crucial to analyze the historical evolution of education and its role in social and economic development.

The concept of the right to education, expanded over time, emerged with the consolidation of the rule of law and the construction of citizenship, which encompasses civil, political and social rights and duties [18]. Education plays a fundamental role in the formation of national states, especially in a context of social transformation, where blood ties give way to a developing capitalist society.

Several historical factors have driven the need for public education: the strengthening of democracy, the demands for better living conditions, the restructuring of global economic power and, above all, technological advances that require increasingly qualified labor [19–21].

The capitalist economic model, with its free competition and accelerated technological development, generates new knowledge and requires new skills to meet the demands of national states, which seek to maintain their political and economic position [22]. Individual and collective activities become more complex, pressing for the dissemination of knowledge. The State's response to this demand is the consolidation of free and compulsory education [23].

Capitalism is distinguished from previous economic models by "creative destruction" [24], a process of constant innovation that replaces obsolete technologies and products with new solutions. This renewal drives economic development, but requires the constant updating of knowledge and skills.

The school, as a reflection of social transformations, adapts to this reality. New technologies and the knowledge they generate have a direct impact on educational policies, such as the expansion of compulsory and free education, which today reaches the majority of young people up to the age of 17 in several countries (**Tables 1** and **2**) [25].

In short, the discussion about digital technologies in education becomes essential, as the school needs to keep up with the demands of a world in constant technological transformation, ensuring that individuals are prepared for the new social and economic realities.

This movement to expand access to education reaches countries in different periods. We have observed mass education movements in European countries since the seventeenth century, while countries in the global south will move in this direction only in the twentieth century, especially because most of these countries (America, Southeast Asia, Africa) were colonies of numerous European countries [26,27].

Table 1. Compulsory Education in European Countries.

Country	Starting Age	Ending Age	Duration (years)
Belgium (fr)	5	18	13
Belgium (de)	5	18	13
Belgium (nl)	5	18	13
Bulgaria (BG)	5	16	11
Czech Republic	5	15	10
Denmark (DK)	6	16	10
Germany (11 Länder)	6	18	12
Germany (4 Länder)	6	19	13
Estonia (EE)	7	16	9
Ireland (IE)	6	16	10
Greece (EL)	4	15	11
Spain (ES)	6	16	10
France (FR)	3	18	15
Croatia (HR)	7	15	8
Italy (IT)	6	16	10
Cyprus (CY)	5	16	11
Latvia (LV)	5	16	11
Lithuania (LT)	6	16	10
Luxembourg (LU)	4	16	12
Hungary (HU)	3	16	13
Malta (MT)	5	16	11
Netherlands (NL)	5	16	11
Austria (AT)	5	15	10
Poland (PL)	6	15	9
Portugal (PT)	6	18	12
Romania (RO)	5	18	13
Slovenia (SI)	6	15	9
Slovakia (SK)	5	16	11
Finland (FI)	6	18	12
Sweden (SE)	6	16	10
Albania (AL)	6	15	9
Bosnia and Herzegovina (BA)	6	15	9
Switzerland (CH)	4	15	11
Iceland (IS)	6	16	10
Liechtenstein (LI)	6	15	9
Montenegro (ME)	6	15	9
North Macedonia (MK)	6	16	10
Norway (NO)	6	16	10
Serbia (RS)	6	15	9
Turkey (TR)	6	16	10

Source: European Commission [28]. Table prepared by the author.

In Brazil, for example, compulsory education as a right for all is only implemented with the Federal Constitution of 1988 and the Laws of Guidelines and Bases of Education of 1996—there is, therefore, less than 40 years of consolidation of a national right of access to primary and secondary education free and compulsory.

It was only in 1999 that Brazil achieved universal access, that is, almost 100% of children were able to access school. In 2003, free access is extended from the age of 4. This situation is similar in other South American countries and there are still obstacles to achieving high levels of access to the minimum basic education necessary in a complex world permeated by new technological knowledge.

Table 2. Compulsory education in Latin American countries.

Parents	Starting Age	Ending Age	Duration
Argentina	4	17	13
Bolivia (EP)	4	17	13
Brazil	4	17	13
Chile	5	17	12
Colombia	5	14	9
Costa Rica	4	16	12
Cuba	9	14	6
Ecuador	3	17	14
El Salvador	4	14	10
Guatemala	4	14	10
Honduras	5	16	11
Mexico	4	17	13
Nicaragua	5	11	6
Panama	4	14	10
Paraguay	5	17	12
Peru	3	16	13
A. Dominican	5	17	12
Uruguay	4	17	13
Venezuela (RB)	3	17	14

Source: Unesco [10]. Table prepared by the author.

When one observes within the context of the last 50 years, with the intensive development of digital technologies and economic reconfigurations, one observes an increasingly important role of the school in the education of students. There is an intensification of the process of creative destruction [24], in which obsolescence is not only something that is the result of competition, but socially programmed to foster the continuous search for what is announced as new, even though it is already outdated.

The school is immersed in this contradiction, as it is called upon to meet contemporary demands, to include digital technologies in its curricular structures, to provide adequate teacher training, in order to ensure that students have the best technological experiences [29].

Despite this, it is not clear what these experiences would be, as the continuous incipience of technologies hinders the conceptual construction of educational policies and practices related to educational technologies.

One of these concepts concerns digital education, in which it seems to be an education with policies and practices that are fundamentally digital, but which mean more of an education process in which digital technologies are inserted as elements of pedagogical mediation [30]. Because it is an unfinished history, whose process is in full movement, we see the emergence of numerous nomenclatures that seek to respond to what is not answered with generalizable scientific references.

It cannot be inferred that the school moves towards essentially digital dynamics, because as a historical process, the analog and the digital merge and result in new transformative productions, whose nomenclature cannot be elaborated only in the sense of seeking to present something as innovative (new), but as a process whose speed makes us continuously reflect on the paths that become possible for school education.

But, at the same time, the school is the place of tradition, of the maintenance of certain structures of knowledge that cannot be deconstructed due to the technological development of the market.

The school, in the experience of these dilemmas, suffers pressures to incorporate all new technological development into its didactic-methodological structures. This can be observed when discussing the introduction of radio in schools [31], the expansion of the debate to incorporate other media, such as television and cinema, in school education, the debate on the use of video games in the processes of teaching and school learning [32–34]. Currently, the contemporary debate is about generative Artificial Intelligence and its uses and applications at different school levels [35].

More reactive movements are perceived, in which technological innovations need agile social responses—when the questions can perhaps be elaborated in other contexts. One of them is the understanding that the school is made up of people enrolled in a world in which digital technological developments prevail in numerous sectors. These technologies are not disconnected from the subjects' own experiences, which makes them build—with or without the school—conceptions of the world and technological appropriations.

Studies in recent decades have sought to answer how to introduce digital technologies in schools to achieve improvements in student performance [36] promote transformations in the ways of organizing curricula and preparing teaching materials, develop new educational models based on contemporary technologies, or even meet social demands so that the school incorporates technologies that are part of the daily lives of students and teachers [4].

The distinction that is configured with contemporary digital technologies in this set of pressures on the school to incorporate the latest technology in use also gives rise to adjectives that erroneously characterize education, as if digital meant a structural change in the school system, when, in fact, it means teaching something to someone with the mediation of digital technologies [30].

The reading that it is the school and its subjects (teachers and students) who must adapt to the technological condition ends up building an image that the alleged scientific progress and development are developments of machines and not of humans.

It is humanity that develops, with new generations of people who are capable of innovating. Contrary to the common perception that machines "evolve" by themselves, especially from the perspective of "new technologies" in a context of capitalist production and consumption, technological development occurs within the culture that human beings create, driven by human labor and social demands [20].

Therefore, it is considered that what is commonly called "new technologies" emerges from the possession of the logical and material instruments essential for their effectiveness in the current context. From this perspective, it is proposed that contemporary technologies are rooted in the material and techno-scientific evolution of humanity. In addition to the historical foundation, the social demand for innovation and novelties in the productive sector exerts a significant influence on technological development. Thus, based on [20] theoretical examination, it is understood that no technology surpasses the capabilities and aspirations of its time, the latter being shaped both by the need and by the consumption characteristic of the historical society in focus.

From the point of view of educational policies, there is great social pressure for the school to meet these contemporary demands, proliferating educational policies that establish guidelines on what, how, and when digital technologies are used in educational systems [28,37]. But, by disregarding the human factor in the educational equation, there is a risk of creating teaching and learning models that do not bring the needs of human reality—what students and teachers need in their daily educational constructions in the geographical-cultural contexts in which they are inserted.

The influence of digital technologies on school performance is difficult to measure [38] There are still few empirical results demonstrating the direct relationship between the use of digital technologies and educational improvement [39]. The following image demonstrates this difficulty, since there is no direct relationship between a country's wealth and investment in infrastructure for continuous use in the schools of the state.

Even so, there is a social pressure for school curricula to become increasingly involved with digital technologies [40], indicating significant transformations in teacher training and producing transnational documents aimed at the construction of global conceptions related to good practices of technology-mediated education [10].

In within the context of German education, we observe that there is an intense movement by the federal government and the states [41] so that digital education policies are incorporated in schools – whether through the purchase of equipment, teacher training or students. What can be observed from a temporal point of view is that more light is shed on the uses of digital technologies, whether through face-to-face education or through distance education [42].

The German context still has incipiences in the implementation of more "technological" curricula and more universal access to technologies [43]. In Germany, even in times of Covid and school closures, there was resistance to implementing remote education (mediated by technologies) in the country [4].

Data from UNESCO (2023) show that, despite the strength of the German economy worldwide, it is in an intermediate position in terms of the number of computers in the classroom per student.

Countries such as Israel, Poland, New Zealand, Slovakia, and Australia [44] have more established proposals for integrating technologies into basic education. In contrast, many other countries are still studying and analyzing the incorporation of DICT as knowledge that is problematized and discussed within curricular structures [45] The main difference lies in the fact that European countries benefit from collective funds to support technological education policies, whereas others must implement these policies independently [46]

In a comparative study of OECD countries, Arruda [25] found significant disparities regarding the integration of technologies into curricula. European Commission [27] highlights the need for European countries to adapt their educational policies to enhance technological integration in compulsory education. However, more concrete discussions on actionable steps among these countries are still lacking.

In general, there are indications that educational policies and teachers understand the importance of the school including technological knowledge, however, the challenge is to understand the types of pedagogical proposals that can emerge.

This understanding may not be an easy task, as technological changes present themselves in faster ways than pedagogical discussions seem to adjust. The debates on artificial intelligence show us this, as they already present new teaching challenges in a context in which not even the previous challenges were properly debated and implemented.

The pressure on teachers also occurs through transnational documents prepared by entities such as the European Commission, UNESCO and OECD that establish goals, strategies, analyses on computer use, and data on teacher training.

These questions show us that understanding the movements that teachers make around making their practices more digital, in the sense of incorporating more digital technologies as mediators of the teaching and learning process is not an easy task. This is because most of the documents concern general policies, in which there is no faculty participation, or at least, faculty voices are not perceived in the results of the proposals presented [47].

3. Education policies and digital technologies in within the context of compulsory education in Germany

In this section, we will present the main educational policies that aim to consolidate digital technologies in within the context of teaching practices and school daily life.

Digital technologies have occupied the world landscape and, especially in Education, in recent decades. Successful navigation in complex digital landscapes is proposed as an important prerequisite for participating in economic, social and cultural life [48].

The actions presented are conducted by the federal government, the Federal Ministry of Education and conducted individually by each state of the federation, through adaptations to local and political characteristics. The national policy is named Initiative Digitale Bildung (**Table 3)**.

Table 3. Overview of the initiatives: Initiative digital Bildung—DigitalPakt Schule and Medienkompeten.

Initiative	Goal	Resources
Initiative Digitale Bildung	Promoting the integration of technology in education	Grants to schools for educational technology procurement, teacher training programs
DigitalPakt Schule	Modernizing digital infrastructure in schools	Funding for the purchase of IT equipment, such as tablets, computers, and internet access
Medienkompetenz	Developing students' digital skills	Curriculum development to promote digital literacy, teacher training programmes

Score: Prepared by the author.

These initiatives of the German government bring with them the understanding that teachers and schools need to understand the place that digital technologies occupy in society, in order to transform the school environment and provide a more critical and analytical education of youth, which leads numerous governments to significantly increase the funding of initiatives focused on software and hardware, as well as teacher training, in the school environment [49].

From the perspective that digital transformation in the school environment is a challenge that the German federal government has been facing for at least two decades. [50], German educational policy understands that schools are the legitimate place to prepare students for the digital world [51,52].

As previously presented, the federal government presents itself as the main actor in this context of digitalization, but the control of the digital transformation in the education system falls on the German states [53].

Germany's digital education initiative, promoted by the Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research), was strengthened especially after 2020 due to the Covid-19 pandemic and expanded in 2021 with the creation of the Digital Education Network.

According to the German federal government, the digital education initiative intends to improve the learning, teaching, and training of students and teachers, at all educational levels to empower all generations to confidently navigate the digital world.

This initiative works to support the construction of the necessary digital infrastructure and the development of digital learning tools for the qualification of education professionals, emphasizing contemporary content and methods. The objective is to foster the development of students' digital skills throughout their educational trajectory, preparing them for a digitized future.

3.1. DigitalPakt Schule

One of the initiatives that seek to bring greater prominence to the federal government is part of the administrative agreement called "DigitalPakt Schule". This federal project intends to promote the digital transformation of the school system, establishing and expanding digital education infrastructures, especially through the provision of financial resources to states totaling 5 billion euros [54].

The states themselves are also making half a billion euros available for administrative implementation in schools to support them in the development of media concepts and training in media education. In 2020, funding was increased by a further

€1.5 billion due to the COVID-19 pandemic [51], bringing this policy to €6.5 billion, according to the **Table 4** below.

Table 4. Financial information on the digital compact.

State	Part	Digital Pact	Each ZV	Total ZV	Total
Baden-Württemberg	13.01%	650,640,000	65,064,000	195,192,000	845,832,000
Bavaria	15.56%	778,245,500	77,824,550	233,473,650	1,011,719,150
Berlin	5.14%	256,877,000	25,687,700	77,063,100	333,940,100
Brandenburg	3.02%	150,901,000	15,090,100	45,270,300	196,171,300
Bream	0.96%	48,142,000	4,814,200	14,442,600	62,584,600
Hamburg	2.56%	127,895,000	12,789,500	38,368,500	166,263,500
Hesse	7.44%	372,172,000	37,217,200	111,651,600	483,823,600
Mecklenburg-Western Pomerania	1.98%	99,209,500	9,920,950	29,762,850	128,972,350
Lower Saxony	9.41%	470,496,500	47,049,650	141,148,950	611,645,450
North Rhine-Westphalia	21.09%	1,054,338,000	105,433,800	316,301,400	1,370,639,400
Rhineland-Palatinate	4.82%	241,229,500	24,122,950	72,368,850	313,598,350
Saarland	1.20%	60,098,500	6,009,850	18,029,550	78,128,050
Saxony	4.99%	249,542,500	24,954,250	74,862,750	324,405,250
Saxony-Anhalt	2.75%	137,582,000	13,758,200	41,274,600	178,856,600
Schleswig-Holstein	3.41%	170,263,000	17,026,300	51,078,900	221,341,900
Thuringia	2.65%	132,368,000	13,236,800	39,710,400	172,078,400
In total	100.00%	5,000,000,000	500,000,000	1,500,000,00	6,500,000,00

Source: Prepared by the author.

The main goal of "DigitalPakt Schule" is to ensure that all schools in Germany have access to cutting-edge digital technology, including high-speed internet connections, digital devices for teachers and students, and digital learning platforms (**Table 5)**. In addition, it intends to improve the digital skills of both students and teachers, incorporating digital education in a transversal way into the school curriculum [54].

Table 5. Summary of objectives, resources available.

Aspect	Description
Resources Made Available	- Financing for the acquisition of IT equipment, such as computers, tablets, digital devices for teachers and students. - Investments in network infrastructure to ensure high-speed internet connections in all schools. - Development of digital learning platforms and online educational resources. - Training programmes for teachers on the effective use of technology in education and the integration of digital education into the school curriculum.
Source of Information	German Federal Ministry of Education and Research [41]
Expected Impact	The DigitalPakt Schule is expected to promote equal educational opportunities, improve the quality of teaching, and prepare students for the ever-evolving digital world.

Source: Of information and expected impact of the DigitalPakt Schule in Germany.

Germany is also working on a strategy of dialogue between different sectors, to promote a digital transformation in its governance. Included in its policies is the Berufsbildung 4.0, whose main objective is to promote a transformation of digital training in the field of digital education.

There is also the "Nationale Weiterbildungsstrategie (NWS), which is an initiative of the German government, focused on improving access and quality of continuing education for all citizens. The objective is to enable professional participation in an increasingly digitized world, establishing quantitative and qualitative goals, such as increasing participation in continuing education programs. The strategy envisages facilitating access to mentoring, funding and continuing education offers, strengthening digital education and developing skills for the future, within an agreed framework of work among NWS partners.

It is observed, therefore, that the German State merges as a protagonist and possible monopolist in the provision and sponsorship of digital implementation in educational institutions [54]. Although the German educational system is characterized by the freedom that states and municipalities have in relation to their organizations and the provision of compulsory education, the fact that there are financial resources distributed at the federal level means that there is a national coordination that directs certain actions and decisions in terms of education and digital technologies.

It is noted that there is a significant emphasis on the implementation of equipment in German schools, especially in the presentation of the amounts distributed to the states, however, there is less emphasis on both the distribution of money and the presentation of concrete initiatives for teacher and student training [53].

There are at least three strands of action that guide the implementation of digitalization in schools in Germany, each playing a specific role in what is termed "educational transformation". The first action concerns the pedagogical and didactic opportunities of digitalization.

This action implies the pedagogical opportunity to use digital technologies in the school's daily life. This action is developed in line with other actions, such as the purchase of equipment (tablets), for teachers and students.

There is a wide process of purchasing such equipment, all specifically from the Apple brand, due to the problems arising from data protection in equipment that has operating systems such as Microsoft Windows or Google Android.

The equipment, provided to teachers and students, is previously loaded with software available in the Apple Store—some with limitations on use, others with free access.

It is possible to find on the federal government's website some results of the actions developed in schools, available through videos, teaching plans, materials prepared by teachers and students.

The second action involves the support and qualification of teachers. According to the documents collected on the pages of the German Ministry of Education (https://www.netzwerk-bildung-digital.de/), this includes short courses for teacher training, pedagogical materials available on the page, as well as other types of productions in different media supports for rapid teacher training. Each state can hire, according to the financial resources received by the federal government, media consultants, who work with schools and practical teacher training centers to support school development and teaching related to digitalization. According to the data provided, these consultants work in direct contact with those responsible for digitalization who work in schools.

The third action comprises access to digital media and technological infrastructure.

As already presented, in addition to the purchase of equipment, this approach also involves a transformation of the school infrastructure, providing the school with high-speed internet access, the establishment of a sustainable technological base of Information Technology (IT) that supports innovative educational practices and promotes an environment conducive to the effective use of digital technologies.

3.2. Medienkompetenz

Medienkompetenz addresses several key competencies to promote safe, creative and responsible use of the media [52]. Some of the key competencies addressed by this framework include:

Table 6. Competencies addressed by Medienkompetenz.

Competence	Description
Digital literacy	Ability to use and understand digital technologies, including basic internet navigation skills, use of applications and software.
Critical evaluation of the media	Ability to critically analyse and evaluate information from different media sources, discerning between reliable information and misleading or biased content.
Understanding online privacy	Knowledge and understanding of the concepts of online privacy and security, as well as skills to protect personal information and avoid risks related to internet security.
Digital Troubleshooting	Ability to identify and resolve technical issues related to the use of digital technologies, including skills to troubleshoot software, configure devices, and handle digital security issues.
Digital creativity	Ability to create and produce original digital content, using a variety of digital tools and platforms, such as image, audio, and video editing software, as well as skills to collaborate creatively on online projects.
Digital citizenship	Awareness of the rights, responsibilities, and ethics related to the use of digital technology, including responsible online behavior, respect for digital diversity, and active participation in the online community.

Score: Synthesis prepared by the author.

These skills are also based on the European Community's Digital Skills Framework **(Table 6).** It cannot be attributed to a perspective of training subjects to be digitally competent, and this is an aspect that is difficult to clarify, especially with regard to the measurements of how much teachers and students learn or apply their knowledge from technological training [30].

With regard to teacher training, [55] understand that it is challenging to obtain a holistic, broad view of students' digital competence. The great difficulty lies in the need to educate students to become capable of using technologies productively and, at the same time, to be able to do so.

The great difficulty in this perspective lies in the fact that there are educational policies that foster this formative path, but, at the same time, little understanding of what these transformative skills would be that allow students to interpret in specific practices, classroom organization, how to better position themselves with digital resources and how to better support student learning [56].

However, it should be noted that the discussion on digital skills concerns the need to include in public policies a direction for a type of training and educational investment that makes it clear that it is about expanding the debate on the implication of digital technologies in the training of students and teachers.

This means that there is a continuous tension between theory and practice—between the policies developed in the institutional spaces of the federal or state departments of education, at the same time that the reality experienced by students and teachers is present and pressures teachers for decisions different from those presented by the formulators of educational policies.

In the German case, it is observed that the institutional movement expands, especially in the post-covid context, in an action integrated with other actions, such as the Disk project (Digitalstrategie Lehrer innenbildung Köln: Kompetenzen nachhaltig entwickeln), which establishes formative dimensions for students and teachers for digital skills.

Table 7. Summary of the main approaches of the Disk project.

Formative Dimension	Description
Student Skills	Digital literacy: the ability to use and understand digital technologies. - Critical thinking and media evaluation: ability to analyze and critically evaluate information from different media sources. - Digital creativity: ability to create and produce original digital content. - Digital citizenship: awareness of the rights, responsibilities and ethics related to the use of digital technology.
Teachers' Competencies	Technological enablement: the ability to effectively use digital technologies. - Digital curriculum development: ability to effectively integrate digital technology into school curriculum planning and execution. - Online teaching skills: competencies to teach effectively in digital environments. - Digital assessment and feedback: the ability to use digital tools to assess student performance and provide feedback.

Score: Prepared by the author.

Despite these efforts, there are difficulties in establishing mechanisms for measuring results, as well as the context in which the concept of digital skills is inserted [57].

In addition, there is still some difficulty in defining, clearly distinguishing general and specific technological knowledge (**Table 7)**. This is a critical question, as it implies defining which digital competencies are fundamental for all teachers, regardless of their area of specialization, and which competencies require a deeper understanding that is specific to certain disciplines [58].

The perspective of the speed with which digital technologies are developed and how the school, with its different times and movements, is forced or not to incorporate such novelties is also considered problematic [59].

The challenge here is to establish a historical relationship in which technological advancement does not compromise teaching practices, either by including or excluding more recent digital technologies, preventing them from becoming obsolete.

Teacher training initiatives are also observed through virtual learning environments and various materials aimed at the development of digital skills among teachers. This environment, as announced, is available to all schools.

In addition, in terms of documentation and initiatives, we can observe that there is a significant production on the federal government's website, in which the participation of civil society and universities is also pointed out as partners in different

initiatives aimed at presenting proposals for teacher and student training to improve the use of technologies in the school environment.

As it is an educational policy in constant movement, dating from intensified actions after the COVID-19 period, it is possible to characterize it as still incipient and, therefore, difficult to measure externally. From a historical perspective, most of these policies are less than four years old, which underscores the need for more comprehensive analytical research on the results achieved by all actions undertaken by the German government.

4. Discussion

As presented in this work, the recognition of the historical character of digital technologies seeks to inscribe them in a place different from the simple technical insertion of objects or services in the school environment. As a historical process, technologies are part of the daily lives of teachers and students in different environments, school or not.

In this sense, it is not possible for us to think about maintaining a teaching practice that manifests itself in an analog perspective, because such a perspective can no longer be apprehended in isolation, since society is intensively mediated by digital technologies that reconfigure the lives of people at all ages.

In addition, one cannot leave aside the economic perspective that inscribes the consumption of digital equipment and services, given that the so-called big techs, such as Apple, Microsoft, Alphabet and Meta are today the most valuable companies in the world.

When we look at the institutional documentation, we observe that the three states analyzed have ample documentation in which they indicate policies for teacher and student training to develop activities mediated by technologies. Such documentation can be found on the official pages made available through the web pages of each state. There is a consistent set of materials in different types of media (texts, audio, video, animations), which demonstrate that there are policies aimed at teachers and students, both in terms of training dimensions and the availability of equipment.

The policies and actions found corroborate the national policies for the implementation of digital technologies in the school environment, as previously presented [60].

It is observed that there are distinctions in relation to nomenclatures, but educational policies are similar in the three states studied, with emphasis on the aspect of access to technology, with the provision of equipment for teachers and students; teacher training, on a continuous basis, based on the availability of materials, as well as individualized consulting, to foster the use of digital technologies in the school environment.

The training of students is widely encouraged as part of the process of pedagogical practice of the teacher and educational planning of the school.

At the same time, it is important to observe that public policies have what we consider to be inscribed in the legal system, which may have been produced with or without social participation. There is also what is considered external to this order,

which represents the interpretations that the subjects who are the targets of the policies conduct.

Thus, although we can observe a solid movement around different institutional actions, such as teacher training, purchase of equipment, distribution to school students, etc., it is necessary to understand how teachers see themselves as targets of these policies.

In this sense, it is important to note that the demands for greater training in technological terms indicated in the results of the research indicate that the teacher is still far from the knowledge he considers necessary to act adequately in the classroom. We consider it opportune to deepen the knowledge of teacher training, to understand whether these training demands are observed in initial training or in continuing education in the service of teachers.

We observed that there is a strong feeling about the importance of teachers working with digital technologies in their pedagogical practices, while demonstrating fewer actions of this type in the classroom.

These distancing can be explained by gaps in teacher training [61,62], but they can also be understood through other argumentative perspectives, such as teacher resistance to technology, difficulties of inclusion in the conventional model of the current school, with determined times and spaces [63].

We observed that it is necessary to deepen the approaches, as well as the theoretical discussion in order to seek to overcome apparent answers with which we have been living for some decades in the area of educational research.

Teacher training and the use of technologies, infrastructure, and educational policies sensitive to the needs of teachers and students are reasonably developed within the scope of educational research [64,65], according to the broad framework presented so far in this report.

From the historical perspective of technology, the approach may need to be reconfigured, in terms of thinking about elements not yet thought of in educational research.

The dimension of school time is one of the issues that deserve attention. The heterogeneity of informational genres in different supports (audio, video, software, games, digital social networks, etc.) imposes other educational times, which include not only the preparation of materials, but also the times of interaction between students and teachers in the school environment.

This involves including in school times, for example, the activation times of technologies (on, off, etc.), the specifics of each media and its settings for class times, and the speed of updating or modifying digital objects incorporated in the classroom.

The school, as a social organizer of the new generations, lives with the technological transformations that affect teachers and students and, at the same time, operates under a model that still maintains a traditional structure of quantitative and temporal distribution of curricular contents.

Teachers find themselves in the apparent contradiction of being frequent users of technologies that address this theme, within the scope of their disciplines, at a lower level than they would like.

Here is the revised and more fluid version of the text in English, preserving its original meaning and authorship:

An analysis of official documents from the states of North Rhine-Westphalia, Bavaria, and Baden-Württemberg reveals that the topic of digital technologies is predominantly linked to the use of devices such as computers, tablets, software, and digital services. This understanding is also evident in reports from UNESCO, OECD, and other organizations, reflecting a widespread perception that education in digital contexts necessarily involves the use of such tools and services.

From the perspective of these documents, digital practices are often defined by the use of technological devices and instruments, while the conceptual, social, and cultural dimensions of digital technologies are given less emphasis. This interpretation is mirrored in educators' responses, which typically highlight the need to integrate digital equipment into the context of digital education.

We argue that digital education, within the current school model, can be implemented even without the presence of physical or logical devices. This would require a curricular reorganization that shifts the focus away from technical elements and instead prioritizes the conceptual and social dimensions of technology in school settings.

5. Conclusions

The exploratory research in focus reveals a complex and multifaceted overview of the integration of digital technologies in education, particularly in the post-pandemic context, comparing perspectives and mobilizations of teachers and educational institutions in Germany. The results show a growing awareness of the importance of digital technologies in education, a mobilization around the adoption of digital pedagogical practices and a still cautious position in relation to emerging technologies, such as artificial intelligence.

The report addresses Germany's education policies in within the context of the integration of digital technologies into compulsory education, highlighting the central role of the federal government and the states in promoting digitalization in schools. Initiatives such as "Escola DigitalPakt", with funding of 5 billion euros, aim to expand digital education infrastructures, including high-speed internet connections, digital devices for teachers and students, and digital learning platforms. The survey points to a significant awareness and mobilization among teachers around the importance of digital technologies in education, evidencing an alignment with the established political guidelines.

In addition to technological integration, the study highlights the importance of a critical reflection on the use of digital technologies and their relationship with digital citizenship. Promoting ethical online behavior, raising awareness about internet safety, and combating misinformation are key aspects of digital literacy that should be incorporated into pedagogical practices. This approach not only prepares students to navigate safely and responsibly in the digital world, but also fosters a deeper understanding of the social, cultural, and political implications of digital technologies.

The post-pandemic scenario has brought both challenges and opportunities for digital education. On the one hand, the need to quickly adapt to remote teaching has exposed gaps and inequalities in access to and use of digital resources. On the other hand, it has provoked an accelerated reflection on the pedagogical possibilities of

digital technologies, driving an educational transformation that could have lasting effects.

The data collected and analyzed suggest several directions for future investigations and educational practices. First, there is a clear need for research that explores effective pedagogical strategies for the implementation of emerging digital technologies in education. In addition, research on the continuous training of teachers in digital skills is vital to overcome the identified barriers. In addition, it is essential to develop holistic educational policies that promote not only technological integration, but also critical reflection and digital citizenship education as core components of education.

Continuous teacher education emerges as a key pillar to ensure that educators are not only familiar with digital tools, but also empowered to integrate them in a pedagogically effective way into their practices.

This implies a more strategic and systematic approach to teacher professional development, where learning about digital technologies is continuous and aligned with rapid changes in the field of technology.

Mediante tais resultados é possível concluir que, as políticas educacionais da Alemanha em relação à digitalização na educação estão alinhadas com as percepções e práticas dos professores, evidenciando um progresso notável na adoção de tecnologias digitais nas escolas. No entanto, a pesquisa identifica áreas para desenvolvimento contínuo, particularmente na preparação dos professores e alunos para tecnologias emergentes, o que pode enriquecer ainda mais o cenário educacional alemão e oferecer direções futuras para a política educacional.

The path forward requires continued collaboration between educators, policymakers, and academic communities to fully exploit the potential of digital technologies in promoting equitable, inclusive, and transformative education. It is hoped that this research can offer significant contributions to Germany's educational policies with regard to digitalization in education. It is essential to align these policies with teachers' perceptions and practices, especially in the face of rapid growth in this field. It is believed that empirical studies play a crucial role in the planning and implementation of educational actions related to the field of technologies and teacher training.

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References

1. Arruda EP, Kerres M. Education Practices Mediated by Digital Technologies: Mobilization and Teachers' Strategies in Primary and Secondary Schools in Germany. Education Sciences. 2024; 14(8): 838. doi: 10.3390/educsci14080838

2. Teräs M, Suoranta J, Teräs H, et al. Post-Covid-19 Education and Education Technology 'Solutionism': a Seller's Market. Postdigital Science and Education. 2020; 2(3): 863-878. doi: 10.1007/s42438-020-00164-x
3. Sintema EJ. Effect of COVID-19 on the Performance of Grade 12 Students: Implications for STEM Education. Eurasia Journal of Mathematics, Science and Technology Education. 2020; 16(7). doi: 10.29333/ejmste/7893
4. Kerres M. Against All Odds: Education in Germany Coping with Covid-19. Postdigital Science and Education. 2020; 2(3): 690-694. doi: 10.1007/s42438-020-00130-7
5. Arruda EP. Emergency remote education: elements for public policies in Brazilian education in times of Covid-19. In Rede-Journal of Distance Education. 2020.
6. Selwyn N. Looking beyond learning: notes towards the critical study of educational technology. Journal of Computer Assisted Learning. 2010; 26(1): 65-73. doi: 10.1111/j.1365-2729.2009.00338.x
7. Buckingham D. Digital Media Literacies: Rethinking Media Education in the Age of the Internet. Research in Comparative and International Education. 2007; 2(1): 43-55. doi: 10.2304/rcie.2007.2.1.43
8. Moursund D, & Bielefeldt T. Will new teachers be prepared to teach in a digital age? A national survey on information technology in teacher education; 1999.
9. Papert S. The children's machine: Rethinking school in the age of the computer. New York; 1993.
10. UNESCO. Technology in Education: A Tool on Whose Terms. Glob. Educ. Monit. Rep; 2023.
11. Olofsson AD, Fransson G, Lindberg JO. A study of the use of digital technology and its conditions with a view to understanding what 'adequate digital competence' may mean in a national policy initiative. Educational Studies. 2019; 46(6): 727-743. doi: 10.1080/03055698.2019.1651694
12. Komljenovic J. The rise of education rentiers: digital platforms, digital data and rents. Learning, Media and Technology. 2021; 46(3): 320-332. doi: 10.1080/17439884.2021.1891422
13. Esteve A. The business of personal data: Google, Facebook, and privacy issues in the EU and the USA. International Data Privacy Law. 2017; 7(1): 36-47. doi: 10.1093/idpl/ipw026
14. Decuypere M, Grimaldi E, Landri P. Introduction: Critical studies of digital education platforms. Critical Studies in Education. 2021; 62(1): 1-16. doi: 10.1080/17508487.2020.1866050
15. Grimaldi E, Ball SJ. Paradoxes of freedom. An archaeological analysis of educational online platform interfaces. Critical Studies in Education. 2020; 62(1): 114-129. doi: 10.1080/17508487.2020.1861043
16. Marone M, Van Durme B. Data portraits: Recording foundation model training data. Advances in Neural Information Processing Systems; 2024.
17. Statistisches Bundesamt (Destatis). Genesis-Online. Available online: https://www.destatis.de/DE/Home/_inhalt.html (accessed on 1 June 2024).
18. Marshall TH. Sociology at the Crossroads and Other Essays. Heinemann: London, UK; 1963.
19. Cubberley EP. Readings in the History of Education. Houghton Mifflin: Boston, MA, USA; 1920.
20. Pinto ÁV. The Concept of Technology. Counterpoint: Rio de Janeiro, Brazil; 2005.
21. Cury CRJ. For a National Education System. Moderna: São Paulo, Brazil; 2010.
22. Muller JZ. Capitalism and inequality: What the right and the left get wrong. Foreign Aff; 2013.
23. Beck EM, Colclough GS. Schooling and capitalism: the effect of urban economic structure on the value of education. In Industries, Firms, and Jobs; 2017.
24. Schumpeter JA. Capitalism, Socialism and Democracy. Routledge. 2013.
25. ARRUDA EP. Implementation of digital technologies in the curricula of basic education schools in OECD member countries. (Portuguese). Subsídios à elaboração da BNCC; 2018.
26. Frankema E, & Van Waijenburg M. The great convergence. Skill accumulation and mass education in Africa and Asia; 2019.
27. Ramirez FO, Boli J. The Political Construction of Mass Schooling: European Origins and Worldwide Institutionalization. Sociology of Education. 1987; 60(1): 2. doi: 10.2307/2112615
28. European Commission (2024). Digital learning and ICT in education. Available online: https://digital-strategy.ec.europa.eu/en/policies/digital-learning (accessed on 20 May 2024).
29. Pressick-Kilborn K, Buchanan J, Maher D. Promoting Environmental Education for Primary School-aged Students Using Digital Technologies. EURASIA Journal of Mathematics, Science and Technology Education. 2018; 15(2). doi: 10.29333/ejmste/100639

30. Kerres, M., McElvany, N., Lorenz, R., et al. Education in the digital world: (How) Can digital literacy be taught? In Learning in and for Schools in the Age of Digitality—Opportunities and Challenges for Teachers, Teaching and Learners. (German). Münster: Waxmann; 2023.
31. Tigert JJ. Radio in the American School System. The ANNALS of the American Academy of Political and Social Science; 1929.
32. Gee JP. Why video games are good for your soul: Pleasure and learning. Common Ground; 2005.
33. Turkle S. The second self: Computers and the human spirit. Mit Press; 2005.
34. Arruda EP. Learning and digital games. Campinas: Alínea; 2011.
35. Arruda EP. Digital skills shortages and curricula options in Brazilian PhD programs in education. Environment and Social Psychology. 2023; 9(1). doi: 10.54517/esp.v9i1.1859
36. Haleem A, Javaid M, Qadri MA, et al. Understanding the role of digital technologies in education: A review. Sustainable Operations and Computers. 2022; 3: 275-285. doi: 10.1016/j.susoc.2022.05.004
37. UNESCO. Global Education Monitoring Report 2023: Technology in education—A tool on whose terms? Paris, UNESCO; 2023.
38. Vasquez Cano LY. (2022). Study of sustainable construction for the improvement of the urban image in the district of San Juan de Lurigancho. (Spanish). Universidad César Vallejo; 2022.
39. Mao H, Liu S, Zhang J, et al. Information technology resource, knowledge management capability, and competitive advantage: The moderating role of resource commitment. International Journal of Information Management. 2016; 36(6): 1062-1074. doi: 10.1016/j.ijinfomgt.2016.07.001
40. Ertmer PA. Teacher pedagogical beliefs: The final frontier in our quest for technology integration? Educational Technology Research and Development. 2005; 53(4): 25-39. doi: 10.1007/bf02504683
41. BMBF. Grundsatzpapier des Bundesministeriums für Bildung und Forschung zur Wissenschaftskommunikation. Available online: https://www.bmbf.de/upload_filestore/pub/Grundsatzpapier_zur_Wissenschaftskommunikation.pdf (accessed on 25 May 2024).
42. Dogan ME, Goru Dogan T, Bozkurt A. The Use of Artificial Intelligence (AI) in Online Learning and Distance Education Processes: A Systematic Review of Empirical Studies. Applied Sciences. 2023; 13(5): 3056. doi: 10.3390/app13053056
43. Tiede J, & Grafe S. The Integration of Media-Related Studies and Competencies into US and German Initial Teacher Education. A Cross-National Analysis of Contemporary Practices and Trends. In: Society for Information Technology & Teacher Education International Conference. Association for the Advancement of Computing in Education (AACE); 2019.
44. Webb M, Doman E. Impacts of flipped classrooms on learner attitudes towards technology-enhanced language learning. Computer Assisted Language Learning. 2019; 33(3): 240-274. doi: 10.1080/09588221.2018.1557692
45. Storte D, Webb M, Bottino R, et al. Coding, programming and the changing curriculum for computing in schools. In: Proceedings of the Report of UNESCO/IFIP TC3 Meeting at OCCE; Linz, Austria; 2019.
46. Okoye K, Hussein H, Arrona-Palacios A, et al. Impact of digital technologies upon teaching and learning in higher education in Latin America: an outlook on the reach, barriers, and bottlenecks. Education and Information Technologies. 2022; 28(2): 2291-2360. doi: 10.1007/s10639-022-11214-1
47. Dirckinck-Holmfeld L, Ipsen BJ, Tamborg AL, et al. Modes of Teacher Participation in the Digitalization of School. Designs for Learning. 2019; 11(1): 63-71. doi: 10.16993/dfl.109
48. Wohlfart, O., & Wagner, I. (2023). Digitale Transformation unter Berücksichtigung zentraler Funktionen des Schulsystems–welchen Beitrag leistet der Digital-Pakt Schule 2019–2024?. *PraxisForschungLehrer* innenBildung. Zeitschrift für Schul- und Professionsentwicklung.(PFLB)*, *5*(1), 246-257.
49. Sailer M, Murböck J, Fischer F. Digital learning in schools: What does it take beyond digital technology? Teaching and Teacher Education. 2021; 103: 103346. doi: 10.1016/j.tate.2021.103346
50. Burke PF, Schuck S, Aubusson P, et al. Exploring teacher pedagogy, stages of concern and accessibility as determinants of technology adoption. Technology, Pedagogy and Education. 2017; 27(2): 149-163. doi: 10.1080/1475939x.2017.1387602
51. Kong SC, Abelson H. Computational Thinking Education. Springer Singapore; 2019.
52. BMBF. Karliczek: In Zeiten von Corona fördern wir digitales Lernen wie noch nie zuvor. Available online: https://www.bmbf.de/de/karliczek-in-zeiten-von-corona-foerdern-wir-digitales-lernen-wie-noch-nie-zuvor-11453.html (accessed on 15 July 2024).

53. KMK (Sekretariat der Ständigen Konferenz der Kultusminister der Länder in der Bun-desrepublik Deutschland) & BMBF (Bundesministerium für Bildung und For-schung) (Hrsg). DigitalPakt Schule von Bund und Ländern. Gemeinsame Erklärung. Available online: https://www.dstgb.de/aktuelles/archiv/archiv-2017/dstgb-zu-den-eck punkten-der-bund-laender-vereinbarung-digitalpaktschule/ergebnis-eckpunkte-st-ag-230517.pdf?cid=7p2 (accessed on 15 July 2024).
54. Wohlfart O, & Wagner I. (2022). "DigitalPakt Schule 2019 bis 2024"—Analysis of the structural digitization of the education system in Germany. (German). PraxisForschungLehrer*innenBildung; 2022.
55. BMBF. Wissenswertes zum DigitalPakt Schule. Available online: https://www.bmbf.de/de/wissenswertes-zum-digitalpakt-schule-6496.html (accessed on 15 July 2024).
56. Hepp A. Cultures of mediatization. John Wiley & Sons; 2013.
57. Lund A, Furberg A, Bakken J, et al. What Does Professional Digital Competence Mean in Teacher Education? Nordic Journal of Digital Literacy. 2014; 9(4): 280-298. doi: 10.18261/issn1891-943x-2014-04-04
58. Mattar J, Ramos DK, Lucas MR. DigComp-Based Digital competence Assessment Tools: Literature Review and Instrument Analysis. Education and Information Technologies. 2022; 27(8): 10843-10867. doi: 10.1007/s10639-022-11034-3
59. Lang M. Teacher development of computer use in education in Germany. Education and information technologies; 2000.
60. Clark-Wilson A, Robutti O, Sinclair N, et al. The Mathematics Teacher in the Digital Era. Springer Netherlands; 2014.
61. Braun T, Büsch A, Dander V, et al. Position paper on further development of the KMK-Strategy ‹Bildung in der digitalen Welt›. MedienPädagogik: Zeitschrift für Theorie und Praxis der Medienbildung; 2021.
62. Thyssen C, Huwer J, Irion T, et al. From TPACK to DPACK: The "Digitality-Related Pedagogical and Content Knowledge"—Model in STEM-Education. Education Sciences. 2023; 13(8): 769. doi: 10.3390/educsci13080769
63. Thorvaldsen S, Sollied Madsen S. Decoding the Digital Gap in Teacher Education: Three Perspectives across the Globe. Teacher Education in the 21st Century - Emerging Skills for a Changing World. IntechOpen; 2021.
64. Fernández-Batanero JM, Montenegro-Rueda M, Fernández-Cerero J, et al. Digital competences for teacher professional development. Systematic review. European Journal of Teacher Education. 2020; 45(4): 513-531. doi: 10.1080/02619768.2020.1827389
65. Sarker MNI, Wu M, Cao Q, et al. Leveraging Digital Technology for Better Learning and Education: A Systematic Literature Review. International Journal of Information and Education Technology. 2019; 9(7): 453-461. doi: 10.18178/ijiet.2019.9.7.1246