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ORIGINAL RESEARCH

After the Storm: an Instrument to Measure the Impact of Digital Technologies in Schools

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Abstract
The footprint of digital technologies in education in the last decades is undeniable. After the emergency remote teaching due to the confinement for the COVID19 pandemic an impact analysis is needed. This paper proposes a validation of an instrument that allows schools to analyze the impact of digital technologies in education, and the sociodemographic factors that could influence the perception of that impact. The instrument consists of 3 dimensions: teaching and learning process, organizational elements and barriers and limitations. To validate the instrument, a study was carried out with 1300 schoolteachers from different areas of Spain. The impact assessment with the QUIT questionnaire will help schools to assess the impact of the innovation with digital technologies implemented and to identify the gaps to help the organization to evolve. Given the constant changes of digital technology in education, the impact analysis should be carried out cyclically in schools for policymakers, teacher trainers and headteachers to adapt and enhance the culture of the impact assessment.

Keywords Impact assessment · Digital technologies · Generative artificial intelligence · Innovation · Educational change

Biography of the authors.

1 Introduction

Digital technologies have been impacting education since the beginning of their use until now, especially with the popularization of generative artificial intelligence. Over the years, the evolution of digital technologies entailed changes in different aspects of education: conception of teaching-learning process and education (e.g., Falco, 2017); teachers' role and

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their skills (e.g., Gisbert et al., 2016; Leon-Jariego et al., 2020); curriculum and teaching-learning practices (e.g., Kajamaa, 2020); family-school communication (Eirdreich, 2021), and school organization (e.g., Gairín et al., 2017; Tomte, 2013).

The confinement due to the COVID-19 pandemic put digital technology as a necessary means to be able to teach, learn and communicate, which has also impacted education. The voices of schools, administrations and policymakers suggest that the actions carried out during those times have not been the most successful (Fainholc, 2020). Therefore, it is necessary to make a change in the educational conception (Colao et al., 2020). It seems like educators were not well prepared to carry out the educational practice virtually. In general, it was difficult to maintain quality standards without jeopardizing the health aspects of students, teachers, and families. Most recently, the popularization of Generative Artificial Intelligence (generative AI) has shown the importance of being well-prepared. These are examples of how digital technologies have always been an axis of transformation and innovation that impact society and change the way we communicate, relate, and learn.

As the 2020 Manifesto for a new learning culture says (Observatory of Human Resources, 2020), we must learn from what happened. This means emphasize the collective intelligence of organizations to create, through learning and knowledge, a new reality. The footprint that digital technologies left in education in the last decades is undeniable (Crompton et al., 2017; Scherer et al., 2019). The recent situation caused by the COVID19 pandemic and Generative AI unlocks a new challenge that involves necessarily reviewing practices, solutions and actions. The resulting knowledge can guide actions to adjust to current times. Therefore, the impact of digital technologies on education after COVID19 and the irruption of AI in education needs to be analyzed.

The purpose of this paper is to help schools to analyze the impact of the irruption of some digital technologies that indubitably imply big changes. Therefore, this paper aims to validate an instrument to analyze the impact of the use of Digital Technologies in educational organizations, and to identify the factors that may affect this impact.

1.1 Education during Confinement

During the confinement months due to COVID-19 pandemic, schools were forced to use digital technologies as the main resource for teaching. UNESCO (2021) estimates that was the case for 800 million students of primary and secondary education, whose schools were closed or experienced a significant reduction of academic schedules during at least 3.5 months. This situation, extended over time, forced educational centers to start different activities supported by digital technologies to be able to continue with the education of children around the world. To analyze the consequences of all of it in the teaching-learning process, the organizational elements and the barriers and limitations different studies were carried out.

Regarding the teaching-learning process, the most impacted aspects were the irruption of the virtual model as the environment for training, the constant adaptation of the curricula and the planned activities, and the difficulties to diversify training activities to attend diversity and students with learning problems (Bull et al., 2021). In this line, different activities supported with digital technologies were applied: virtual museums (Memento Mori), women empowerment through conversations on videoconferences (The Jam Project) or vid-

eos on post-covid resilience (Teens in Confinement), all of them, available at the UNESCO website, through their initiatives (https://es.unesco.org/covid19/initiatives).

In the case of the organizational elements, the most modified aspects during the closing of schools were the teachers' duties and roles (Schalk et al., 2022); the processes for managing schools, especially in relation with communication with families, resources for virtualizing the teaching process and decision making oriented to overcome the digital breach (Palau et al., 2021). Moreover, the management of school transitions from primary education to secondary education was also affected (Bagnall et al., 2022). Given the unexpected situation, new strategies were put into practice and that requires an analysis of the impact to go deep in future consequences.

Finally, about limitations and barriers, Mosleh et al. (2022) highlight the impact of the use of technology in teachers' stress and burnout. In new advances, technology hinders their correct performance; and they conclude that implementing better strategies for unexpected situations is a must in school management. On the other hand, Maity et al. (2020) confirm other limitations such as the lack of connectivity and the availability of digital devices, as well as the low level of students' digital competence. Several studies focus on the digital resources of schools during the confinement months. In general, the key resource was mainly communication tools: virtual platforms, videoconferences, and social networks such as Facebook or WhatsApp (Leiva & Villaroel, 2020; Maity et al., 2020; Salzano et al., 2021). However, some studies warn that maintaining exclusively the use of these tools can really have a negative impact on professional identity, leadership, creativity, and engagement of the members of the educational community. Therefore, this situation sustained over time, will fracture school and educational community's culture (Riva et al., 2021). That is why distinguishing between technology as the only option and technology as an integrated and sustainable mean in education is a necessity (Scully et al., 2021).

1.2 Education with Generative Artificial Intelligence

Digital Education Action Plan 2021–2027 (European Commission, 2020) highlights the need to address the digital challenges and opportunities after the pandemic and to present opportunities for teachers, students, and policymakers. Otherwise, we will face more and more inequalities, and a wider digital breach will be created. While AI has been around in education for years, in November 2022 a revolution started with what is called "generative AI", when ChatGPT (an open generative AI software) was introduced to the world. Generative AI can be defined as "a technology that leverages deep learning models to generate human-like content (e.g., images, words) in response to complex and varied prompts (e.g., languages, instructions, questions)." (Lim et al., 2023, p.2). Since ChatGPT popularization, other generative AI tools were developed. Some of the most used are: ChatGPT (OpenAi), Bard (Google), Gemini (Google), Perplexity, Microsoft Copilot and Glarity (the three of them based on ChatGPT system). All of them have a friendly interface and a call-response system that emulates chatting with someone.

Educause Horizon Reports highlight the key technologies and practices that are anticipated to have a significant impact on teaching and learning. In Educause report (EDUCAUSE, 2023), generative AI and AI-Enabled applications for predictive, personal learning were selected as two of the key elements. Generative AI's relevance in the teaching and learning process revolves around reimagining assessment and ethics education; and AI

applications' relevance is based on the work of teaching, the learning management systems and students' services. In this sense, Chiang et al. (2024) establishes that this new scenario requires an approach designed to demonstrate the realization of process-outcome-balanced educational practices through the use of a pedagogical AI agent.

However, what kind of tasks can generative AI tools do in the educational field? Ipek et al. (2023), after an extensive literature reviewing, categorized them in 14 types of tasks: abstracting, literature review, generating literature, translation and paraphrasing, generating complex and deep answers for exams, identifying students' needs earlier, personalized learning experience, grading and assessment, data analysis, prevention of cybercrimes and cyberbullying, helping people study, cataloguing, directing and material design and generation. Another literature review with the help of ChatGPT written by Baidoo-Any & Ansah (2023) summarized the benefits in five: Personalized tutoring, automated essay grading, language translation, interactive learning and adaptative learning. Zhai (2023), also with the help of ChatGPT categorized the uses of generative AI in education in: adaptive learning, personalized recommendation, individualized instruction, early identification of learning needs, enrolment and registration, students record management, grading and assessment and course scheduling. These and other publications that propose educational uses of generative AI (f.i. CYD Foundation, 2023) are mostly based on experts and the generative AI systems like ChatGPT but do not come from empirical research or related to the impact of its use.

Therefore, what is the impact on students, teachers and the educational centers? What has changed in terms of ideas, tasks, assessment and possibilities? Some studies highlighted that there is still a lack of empirical research on generative AI (Song, 2024). A search in Scopus on "generative artificial intelligence" AND "impact" showed zero results while the search "generative artificial intelligence" AND "schools" showed only 28 documents, and all of them were in the context of higher education, most of them about plagiarism and a few about how can teachers and students use generative AI for education.

Even though education can benefit from generative AI, it must also consider its limits, the ethical and legal perspective (ecology, intellectual property, biases…) and its impact in the educational processes. At the nexus of generative AI + education + law, ethical imperatives demand the protection of equity, privacy, and transparency, paramount in both educational and legal realms. Data protection and equitable access to generative AI are essential to uphold the principle of equality before the law and to forestall biases related to social status or power. In crafting and deploying AI, adherence to procedural fairness and due process is critical, ensuring transparency and equitable access to justice for all. Defining the responsibilities of generative AI developers and users is vital, with an emphasis on maintaining integrity and honesty. Generative AI must not only safeguard core legal values such as judicial and legislative efficiency but also enhance them, thus enriching the educational and legal systems as a whole (Harasimiuk & Braun, 2023; Nikolinakos, 2023).

The democratization of generative AI is not a trend or a small change that can be unnoticeable for a long time. In fact, experts on the field were foreseeing this technology as the 4th Industrial revolution (Chakraborty et al., 2022) and its impact will be even bigger than industrial revolutions and digital revolution in the 90s combined (Makridakis, 2017). Thus, generative AI will make (and it is making) a big impact on education, especially when it comes to assessment (Prendes-Espinosa, 2023), schools (CYD Foundation, 2023) and edu-

cators (Chiu et al., 2021) that have the duty to be prepared to effectively incorporate it in their profession with all the relevant information about the changes it is making.

1.3 Conditioning Factors in Teaching with Digital Technologies

Mouton and Marais (1988) affirm that it is essential to analyze the sociodemographic factors that affect the perceptions of the study of a phenomenon. In the field of research of educational technologies, the most common factors studied are gender, age, educational stage, and level of digital competence. The study of Solís et al. (2021) identified that the way in which teachers adapted to the use of technologies during the confinement was different depending on gender and age, finding more rejection to use them in women and teachers older than 46 years old. Along the same lines, Arredondo-Trapero et al. (2021) also confirm the effect of gender in the predisposition to use digital technologies, but, in this study, it was discovered that men were more inclined to find problems with technologies.

Regarding the educational stage, the results of the comparative study of Maity et al. (2020) indicate that the higher the educational stage, the fewer problems are found regarding autonomy of students and teachers' readiness for the use of technologies for education. The level of digital confidence is an incidence factor in the cited studies and others like Scully et al. (2021) or Egan and Beatty (2021), evidencing the necessity of considering it in any study in the field of educational technology. The linkage between Teachers' Digital competence and the impact of digital technologies has been widely studied. Several authors (Guillén-Gámez et al., 2022; Guoyuan et al., 2011; Orellana et al., 2021) agree that the educational digital skills of teachers influence in the integration and impact of digital technologies in the educational process. This influence is shown in the three elements: teaching-learning processes, organizational elements, and limitations and barriers. For instance, the creative use of the digital technologies; the attitudes and confidence towards technology as a limitation and the institutional support and culture (Fu, 2013).

There are several experiences about what happened during the confinement, but other questions must be answered: what is the impact of this emergency teaching with technology in medium-long term? Have the schools gone back to old practices? Are there more or less barriers of digital technologies? To consider that a positive change has been institutionalized and, therefore, an innovation has occurred, a global analysis of changes is needed. However, this analysis needs to be developed afterwards and not immediately after the situation that generated change. This is because the impact could have been momentary but it could have not remained over time. In line with this need, the purpose of this paper is to give schools a questionnaire to analyze the impact of a technological breakthrough that affects schools in some level (such as post pandemic situation or the irruption of Artificial intelligence). Therefore, the objectives of the article are (1) to propose a questionnaire that allows schools to assess the impact of digital technologies and (2) to determine the factors that influence this impact.

2 Materials and methods

The questionnaire was designed to address the methodological gap detected on assessing the impact of the irruption of digital technologies. The first step consisted of an extensive literature review to identify the aspects in which DT could impact in a school. The review was systematized in a grid in which we underlined the key ideas for assessing the impact of DT. Once we finished this revision, 103 key ideas were identified. After a detailed screening, they were grouped and or deleted depending on the redundancy with other ideas. The selection process of the key ideas that became items was based on the theoretical construct and expert input, ensuring pertinence and precision. This first version of the questionnaire had 63 items: the first 7 were sociodemographic factors and the other 56 were related to the impact of technology in education.

The first version of the instrument was used to carry out field research. After the collection of data, a factorial analysis was conducted, which is explained in detailed in the results section. The factorial analysis was applied following the proposal of Ferrando et al. (2022) which is in line of other references such as Briggs & Cheeks (1986), Clark and Watson (1995), Floyd and Widaman (1995) or Izquierdo et al. (2014), among others.

After the factorial analysis, the final instrument was stablished: the QUIT questionnaire (Questionnaire of the Impact of Technology), composed of 56 items. QUIT is organized in two sections. Section A corresponds to closed questions about 7 sociodemographic factors: teachers' gender, age, educational stage in which they teach, self-perception of their level of digital competence, years of service and type of schools (public or private). Section B (Table 1) has 49 items and teachers must assess their level of agreement twice for each: thinking about how the item was before the situation of emergency teaching with digital technologies and how it is afterwards. Both assessments are made from a 4-point Likert scale: 1 Strongly disagree, 2 disagree, 3 agree, 4 strongly agree.

These 49 items are distributed in 3 dimensions:

1. The Teaching Learning process (TL) integrates 15 items that refer to the impact of digital technologies on curricula and the variables of the didactic process such as teaching conceptions, teachers' duties, and formative process. (Aguaded-Gómez et al., 2010; Alnaji, 2022; Kajamaa, 2020).
2. The Organizational Elements (OE) integrates 18 items that refer to the impact of digital technologies on the three main organizational elements: institutional approaches, structure, and relational system. (Area, 2011; Kosherbayeva et al., 2023; Tomte, 2013).
3. The Barriers and Limitations (BL) includes 16 items that refer to the negative impact such as obstacles, limitations, weaknesses, and barriers that digital technologies have generated in teachers' duties, professional conditions and educational and social conditions. (Malo, 2006; Mosleh et al., 2022; Pappa et al., 2024).

Table 1 Example of the structure of the questionnaire in section B

Before				Items	After			
1	2	3	4		1	2	3	4
	X			I can personalize the assessment.			X	

2.1 Data Collection and Data Analysis

The data was collected face to face. Researchers went to the schools to collect the data in several primary and secondary schools in Spain, ensuring the representation of all geographic areas of the country. The anonymity and privacy of the informants was guaranteed throughout the whole process. 1300 responses were collected.

The data was processed in SPSS v15 software. The data analyses to validate the questionnaire were Bartlett's test of sphericity and KMO and Cronbach's alpha for each dimension and the whole questionnaire. To determine the factors' effect on the impact of digital technology changes, ANOVA test with Bonferroni correction (parametric standards) and Kruskal-Wallis's test (non-parametric standards) were applied.

2.2 Sample

The participants are primary and secondary schools in Spain randomly selected and ensuring the representation of different areas of Spain (North, South, East, West and Center Spain). The sample ($n = 1300$) is composed of 62.2% of women of 45.15 years old on average, 19.17 years of experience as teachers and 12.58 years teaching in the same school. Schools of the informants were 73.7% public institutions and 26.3% private institutions. The number of participants teaching in primary and secondary stages was balanced: 50% teaches primary education, 48.9% secondary education and 1.1% in both stages. Regarding digital competence, 11.2% have a basic level, 69.7% intermediate level and 19.1% expert level.

3 Results

The first objective of the paper is to validate the questionnaire through an exploratory and confirmatory analysis.

The initial instrument was created after a literature review to give the questionnaire a construction validity, after identifying the dimensions and items used in previous studies in the field. Afterwards, the researchers carried out the factorial analysis following the steps proposed by Ferrando et al. (2022, p. 8): adequacy of the data and sample, calculation of univariate descriptive statistics, justification of the analysis, selection of the items to analyse, decision of the type of factorial model, selection of the most suitable factorial solution, estimation of the parameters, adequacy of the factorial solution, assessment of the substantive coherence of the model and final version of the questionnaire. Therefore, in the following paragraphs there is a description of all these steps.

The questionnaire was applied to a representative sample of Spanish teachers of compulsory education from public and private schools. Given that the collection was in paper (not digitally), some participants sporadically did not respond to some answers, getting "missing at random" – MAR – (Howell, 2007).

The univariate descriptive statistics are revised: mode, mean, median and standard deviation of each item and all dimensions (Table 2) to check that variance is not close to the maximum homogeneity and, thus, contributing to the common variance. In the analysis by item of the asymmetric and kurtosis values, it is observed that some of the values are over 1 since the questionnaire uses ordinary variables (PCC).

Table 2 Descriptive statistics by dimensions

	PEA	CO	BL
Mode	0.400	0.778	0.563
Median	0.667	0.722	0.500
Mean	0.723	0.713	0.477
Std. Deviation	0.543	0.215	0.311

KMO of the questionnaire has optimal values to factorization (0.798) and Bartlett's test shows significancy ($p<.000$). Moreover, Cronbach's alpha of the questionnaire is high, obtaining a value of 0.832, and the analysis item by item does not show any element that, if removed, would significantly improve the alpha.

The initial questionnaire answered by the participants consisted of 56 items distributed in three components: teaching-learning process, organization elements and barriers and limitations. The items were developed following the theoretical framework revised and assuring that each dimension comprehends items that include its idiosyncrasy. The type of factorial model is non-linear given that the variables are discreet and limited (Liker-scale questions). To analyze their relevance, suitability and importance an exploratory factorial analysis was carried out. The extraction method was the analysis of main components, and the method applied was varimax rotation with Kaiser forcing the distribution of the 3 components proposed in line with the literature review. The results showed that the rotation converged in 6 iterations.

Afterwards, the results of the distribution were revised to check that the items were distributed in the theoretical components, analyzing the highest loads and secondary loads. To make the decision for each item, the quality, precision, and the grade of the marks was considered. Regarding quality (Ferrando et al., 2022) the items with noise (low loads in any factor), cross-loading items (with similar numbers in different factors) and strong load items (high marks compared to the rest of the factors) were assessed. The items with noise were the ones with marks lower than 0.300; complex items were the ones with a difference load less than 0.100 between two components. The strong loads were those with marks over 0.300 and with a higher difference than 0.100 between components. After that analysis, 13 items with noise, 8 complex and 35 markers were identified. Thus, the following decisions were made:

- Items with noise: Considering that these items are not disrupting, but, statistically, are not contributing, they have been revised considering in which component they are placed. If the component is not adequate according to the theory and its load is between two factors (cross-loading items), it was deleted. After this revision, 2 items from the initial questionnaire were eliminated.
- Cross-loading items: The loads of all cross-loading items in each factor were revised to assess (1) if it is located in the theoretical component; (2) if it is not, if it can fit in the component of the highest load; and (3) if their content contributes to the interests of the questionnaire, due to its theoretical importance and/or its contribution to the reflection of the phenomenon in the participants. After this revision, 3 items from the initial questionnaire were eliminated.
- Strong load items: These items were revised to ensure they correspond with theoretical factors. In case they did not but were suitable in another component, they have been

kept. In case they were not suitable for the new component, and they could lead to confusion if included in the corresponding component according to the results, they have been deleted. After this revision, 2 items from the initial questionnaire were eliminated.

Therefore, the questionnaire went from 56 items to 49 items and is organized in three dimensions (Table 3): 15 items in the dimension of teaching and learning process; 18 items in dimension of organizational elements and 16 in the impact of barriers and limitations.

With the purpose of ensuring that the results of the application of QUIT are solid, the sociodemographic factors that could influence the results must be considered. Therefore, the second objective of the paper is to determine the sociodemographic factors that affect the impact of digital technologies in schools. In line with the literature, the following were analyzed: type of school (public or private), teachers' gender, educational stage in which they teach, self-perception of their level of digital competence, age, and years of service.

Regarding the type of school, the results show that there are differences between the means, with a higher perception of impact in private schools on the dimension of teaching learning process and barriers and limitations, but less impact in the organizational elements. Despite that, the differences are not statistically significant in any of the dimensions.

On the other hand, the results show significant differences depending on the gender in the teaching learning dimension [$H(1, n=1118)=6.96$, $p=.008$]. In this dimension, people who identify as a man have detected more impact in the teaching learning process ($M=0.78$, $SD=0.59$) than those who identify as a woman ($M=0.69$, $SD=0.51$). However, in the dimension of organizational elements and barriers and limitations, the results do not show significant differences, although there is the same tendency of identifying a greater impact in organizational elements for men and greater impact in barriers and limitations for women.

The educational stage in which teachers develop their teaching is a factor that impinges on the results of the three dimensions. In this case, those who only teach in secondary education are the ones that detect less impact of digital technologies compared to those who teach primary education in all dimensions: teaching learning process [$F(2, 1111)=4.91$, $p=.005$], organizational elements [$F(2, 1107)=5.58$, $p=.003$] and barriers and limitations [$H(2, n=1141)=63.36$, $p=.001$].

Regarding the self-perception level of digital competence, the results show significant differences in the dimensions of teaching learning process and barriers and limitations, but not in organizational elements. On the teaching-learning process the higher the level of digital competence of teachers, the greater the impact identified [$H(2)=44.05$, $p=.001$]. On the contrary, the greater the level of digital competence of teachers, the lower the perception of impact in barriers and limitations [$H(2, n=1130)=40.02$, $p=.001$].

The age of teachers was organized in 4 groups distributed in: younger than 38 years old, between 39 and 46 years old, between 47 and 54 years old; and older than 55 years old. Age is also a factor that influences the perception of the impact in the three dimensions. In teaching-learning process, teachers between 38 and 46 years old perceive more impact than the rest of the age groups and these differences are significant compared to the group of older than 55 years old [$H(3, n=1107)=40.19$, $p=.000$]. In the dimension of the organizational elements, teachers between 47 and 54 years old are the ones who identify a greater impact in comparison to the rest of the age groups and, especially again, there is significance in the results of teachers older than 55 years old [$H(3, n=1103)=22.48$, $p=.000$]. In the same vein, teachers from 47 to 54 years old are the ones that detect more impact in barriers and

Table 3 Items by dimension of QUIT

Impact on the Teaching-Learning Process (TL)	
TL1. Education promotes personal and professional autonomy	TL9. My evaluation is enriched with more evidence
TL2. The teaching models place the student as the main actor	TL10. I can personalize the assessment
TL3. My credibility as a teacher in the classroom is reinforced	TL11. The type of activities that I include in teaching learning process is more diverse
TL4. My attitude towards teaching is positive	TL12. I can easily personalize learning
TL5. My role as a teacher includes new skills	TL13. The modalities that I use for grouping the students are varied
TL6. Updating content is essential in initial training	TL14. The channels of communication with my students' families are enhanced
TL7. Updating content is essential in continuing education	TL15. Monitoring and controlling school tasks is easy for me
TL8. Communication with my professional contacts is frequent	
Impact on organizational elements (OE)	
OE1. We have modified aspects of the Educational Project of the institution	OE10. The school management promotes spaces for reflection and resources to discuss about digital technologies
OE2. We have modified aspects of the Curricular Project of the institution	OE11. I perceive greater support from the Educational Administration
OE3. We have modified aspects of the Internal Regulations	OE12. The ways of communication between the staff of the center have been modified
OE4. The school have more flexibility in terms of schedules and curriculum	OE13. Our communication with other centers has increased
OE5. Teacher selection processes consider the level of media of instruction	OE14. Coordination between teachers has increased
OE6. We have incorporated a person in charge related to the management of digital technologies	OE15. The coordination is easier
OE7. We have modified the material resources (didactic materials, furniture…)	OE16. Participation in the management of the center has increased.
OE8. We have reinforced security measures (antivirus, alarms, security cabinets…)	OE17. Participation in the management of the center is of higher quality
OE9. The school promotes measures to preserve the privacy of personal information	OE18. I have many professional contacts
Impact on Barriers and Limitations (BL)	
BL1. I spend more time for educational planning	BL9. The organization of the spaces has been conditioned
BL2. My planning is more complex	BL10. Social inequalities have been intensified
BL3. The didactic sequence that I use is always the same	BL11. Digital technologies have increased our bureaucracy
BL4. I feel more supervised at work	BL12. Verbal communication between the staff has decreased
BL5. My classroom management is more complex	BL13. The type of conflict has diversified
BL6. The diversity of teaching means makes me feel insecure	BL14. Conflicts in the center have increased
BL7. Innovation is a permanent demand	BL15. Conflicts are more complex to manage
BL8. Co-habitation in my classroom is more conflictive	BL16. Didactic means make me spend more time working outside school hours

limitations compared to the other group ages [F(3, 1131)=13.16, p=.000] and, especially, compared to teachers younger than 38 years old.

Finally, the number of years that teachers have been in service is also a factor to consider when assessing the impact of the introduction of digital technologies. In the dimension of teaching and learning process, the lower the experience the greater the perception of the impact [H(2, n=1118)=37.64, p=.000]. On the other hand, the dimension of barriers and limitations is in reverse, the greater the experience, the greater the perception of the impact [F(2, 1143)=6.68, p=.001]. Lastly, in the dimension of organizational elements, results have not shown significant differences depending on the number of years that teachers have been in service, neither a tendency of the perception of the impact.

In summary (Table 4), the dimension of the teaching learning process is where the sociodemographic factors have more influence, whilst the dimension of organizational elements is where less occurrence has been observed. The most influencing factors in different dimensions are teachers' age and the educational stage in which they teach. In Fig. 1, we offer a visual representation of the factors and dimensions that the QUIT questionnaire proposes to assess the impact of digital technologies.

4 Discussion

The purpose of this paper was to propose an instrument to analyze the impact of the irruption of digital technologies such as the forced online education situation or generative artificial intelligence and the factors that can influence this impact. The impact assessment of educational practices is indispensable, and it is specially needed to analyze the effect of an intensive use of digital technologies in schools during the COVID19 pandemic (Sahlberg, 2020) or artificial intelligence in education (Song, 2024). QUIT questionnaire is an instrument that facilitates developing and impact analysis, as well as considering the factors that might influence the phenomenon. Schools that implement this type of assessment must consider the teachers' age and the stage in which they are teaching, since they are key factors that may influence their perception. On the other hand, factors such as type of school (public-private) or gender do not need to be considered in this impact assessment, since they have almost no occurrence in the perception.

Although studies confirm that schools and experts have revised the practices carried out during the pandemic (Palau et al., 2021; Watermeyer et al., 2021), a next step is needed in order to go forward and benefit from what it is left after the storm. At the same time, we have concatenated another storm with generative artificial intelligence, that also impacts on the teaching learning process, the organizational elements, and the barriers and limitations of it

Table 4 Incidence of factors to the dimensions of the impact of digital technologies

Factors	Teaching-Learning process	Organizational Elements	Barriers and Limitations
Type of school	-	-	-
Gender	√	-	-
Educational stage	√	√	√
Digital Competence	√	-	√
Age	√	√	√
Years of service	√	-	√

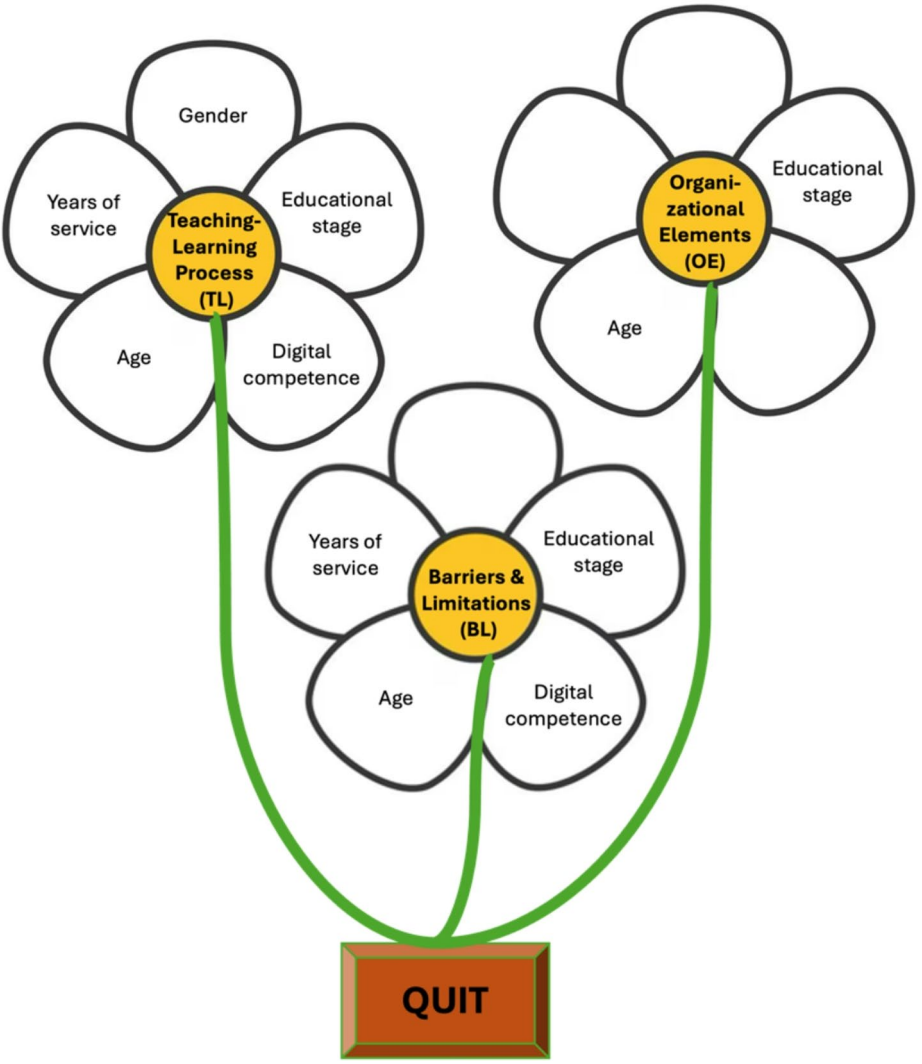

Fig. 1 Factors and dimensions of the QUIT questionnaire to assess the impact of digital technologies

(Southgate et al., 2019). Thus far, the impact assessment of the use of digital technologies has been applied only when something has specifically appeared (Mason & Rennie, 2007; Eirdreich, 2021, among others), but that means that schools are not adapting quickly enough to the needs of society. Given society and the way technology is constantly changing and influencing teaching-learning practices and the educational conception in general (Colao et al., 2020), this impact assessment should be planned and carried out continuously. At the same time, the impact assessment should help to identify difficulties and risks associated to the continuous use of technology such as bad practices including cyberbullying, digital breaches and the risk of splitting the school culture, among others.

Regarding the factors to consider in this impact assessment, those who apply the instrument must consider that they specially influence the perception of the impact in the teaching-learning processes and the barriers and limitations of the change. In the teaching-learning process, in line with previous studies (Eagan and Beatty, 2021; Guillén-Gámez et al., 2022; Scully et al., 2021), gender, age, digital competence, years of service and the educational stage are factors that influence the perceptions of the technology uptake in the teaching-learning processes. In the design of the curriculum innovations, policymakers must prepare and adapt the process to fit the characteristics of their teachers.

When considering limitations and barriers, this study shows the influence of almost all factors on the perception of the impact (age, years of experience, digital competence and educational stage). This is in line with the findings of Mosleh et al. (2022) in terms of years of experience, since burnout seems to be a consequence of the impact of digital technologies in their study. Besides, the findings of the study do not show gender as a factor to influence the perception of the impact of digital technologies in limitations and barriers. Therefore, our findings differ from Arredondo-Trapero et al. (2021) regarding internal barriers being influenced by gender. Thus, except for gender, these sociodemographic factors must be taken into consideration in an impact assessment process in this dimension. Despite that, headteachers must consider whether their schools have diversity regarding the characteristics of the teachers. For instance, school that only have one educational stage, do not need to be worried about this factor because all the results will come from the same educational stage.

In the case of organizational elements, only two factors are influencing the perception of teachers: educational stage and age. This complements previous studies such as Petterson's (2018) which revolved around the revision of organizational processes affected by digital technologies, but without considering the factors that might be influencing it. In the implementation of impact assessment regarding the organizational elements, stakeholders should pay attention to the educational stage of the teachers, because some structures and managerial decisions can be a little bit different depending on the stage which they are referring to. In this sense, continuous teacher training must consider the Digital Competence for Educators, following frameworks like Digilit (Hall et al., 2014) or DigCompEdu (Punie & Redecker, 2017) and adapt the training to the educational stage in which teachers work (preschool, primary and secondary education).

5 Conclusions

The QUIT instrument is a proper questionnaire to conduct that analysis, since it is focused on three key dimensions: teaching learning process, organizational elements and barriers and limitations in the integration of digital technologies in schools. The instrument helps to analyze in which way schools are evolving in that matter. This will also help policymakers, teacher trainers and headteachers to make decisions about it and help the culture of the impact assessment grow. The goal of the use of digital technologies in education is not related to the instrumental potential but to the culture impregnated, the digital competence that every citizen needs to develop and the way that all this shapes and impacts reality. Therefore, the traditional model for impact assessment could be revisited since this context requires more cyclical and longitudinal analysis. An example of QUIT application is

the impact of generative AI in educational institutions. Schools can scan how teachers are perceiving that GenAI is impacting teaching-learning processes (f.i. assessment), organizational elements (f.i. reflection on the topic in the school) and barriers and limitations (f.i. social inequalities).

The utility of QUIT questionnaire falls to the multifaceted analysis of the impact of digital technologies. Usually, the available instruments explain one of the dimensions but lack the combined perspective of the others. Offering a validated questionnaire contributes to the advance of the educational technology field, particularly on current times where the pace of the new developments is challenging such as the post-pandemic scenario and the emerging role of GenAI. Besides, the contribution in the field is also related to the educational practices and organization of the schools, since the results of applying QUIT questionnaire will help schools to understand the changes and adapt their practices to be in line of the needs of the current society. In fact, we urge future studies to study the impact of Generative AI and its implications for teaching and learning practices.

As with every research developed in one country, one of the limitations is the particularities of the context, which does not necessarily translate to every country. In this sense, we think that researchers that want to apply the questionnaire should revise it in order to ensure its contextual suitability, especially in relation to cultural, economic and policy differences. Therefore, we encourage researchers to adapt the instrument in this sense when applied in other countries. However, we think that given that the creation of the variables of the instrument considered international studies, other researchers could use it as a questionnaire of reference and adapt it to carry out the impact assessment. Another limitation is that the instrument does not consider the managerial position of the informants and that could influence the perspective on the impact, which could bias the results. Finally, the self-reported data introduces the possibility of biases. We propose and improvement of the questionnaire for future research that could correct these issues. Future research could incorporate a third perspective that relates to the preferred impact. The instrument proposes the analysis of the before and after impact, but with a third analysis related to what educators think that the impact should be (preferred impact), it would add a layer of analysis that could benefit innovation in educational institutions. In addition, another line of research could include evidence of the new practices installed, following a mixed method approach. At the same time, the questionnaire could benefit from the incorporation of aspects related specifically of the event that causes the impact (COVID19, generative AI…).

In this sense, the continuity of this study relies on the administration of the instrument in different contexts and adapt, accordingly, the teaching-learning process and the organizational elements and remove the barriers and limitations that hinder the right evolution of the educational system to respond to the actual society. It is important that researchers, practitioners and policymakers understand that they must assess the impact of digital technologies in schools and act on it, and not only for special situations but also as a recurring practice. The process must be cyclical and continuous in educational settings. Therefore, longitudinal studies could help to track the evolving impact of digital technologies and ensure a correct adaptation to the current challenges.

In the end, impact assessment processes are essential for policymakers, headteachers and practitioners to make decisions and implement actions based on empirical evidence. At the same time, it allows them to respond to social challenges and technology evolution, contributing to create bridges between science and society.

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