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Integrating educational technologies: critical analysis and perspectives from teacher training students

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Abstract

The growing spread of Information and Communication Technologies (ICTs) across multiple contexts of use has triggered the transformation of traditional educational environments to welcome their use in ordinary teaching and learning processes. However, the mere availability and supply of educational technologies does not guarantee the activation of meaningful and inclusive trajectories for technology integration in the classroom, as the knowledge and competences of teachers and students is still the primary factor to drive an equitable and effective use of technology as a didactic mediator. Considering the challenges of teacher training within an ever-changing technological landscape, this paper focuses on the Italian national context, analysing the perceptions of 830 Italian teachers participating in a training course for teachers (30 credits Training, Prime Ministerial Decree of 4 August 2023) with reference to the use of ICTs in their previous teaching experience. The Italian version of the Intrapersonal Technology Integration Scale (ITIS) was implemented as a tool to collect data and examine the dynamic relationship between the teachers' perceived competences on educational technologies and the factual use they make of them to support teaching across disciplines. Results show useful insights on the reasons underlying the choice of implementing and integrating technology in ordinary teaching practices and unveil possible trajectories to reshape the training paths for teachers. In this sense, this contribution unfolds a deeper analysis of the intersection between teacher professionalism, educational technologies and educational systems' inclusiveness and efficacy.

KEYWORDS: Teacher Training, Information and Communication Technologies, Educational Technologies, Inclusive Education, Intrapersonal Technology Integration Scale.

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1. Introduction

Continuous learning for teachers represents a topic of pedagogical interest not only in light of the social role that teaching is recognised with by scientific literature (Butera et al., 2020; Pantić & Florian, 2015; OECD, 2005), but also with reference to the ongoing transformations that have been affecting the formal educational systems, including the Italian one (Prime Ministerial Decree of 4 August 2023; Potestio, 2022). The need to address a multitude of novel issues, assuming increasingly complex roles and functions, draws attention to the centrality of continuing education to foster constant update and the acquisition of new knowledge and competences. As a result, the constant learning of teachers allows the renewal of didactic practices as a response to new discoveries, methodologies and tools (Starkey, 2020; Hankey et al., 2017). In particular, the evolving landscape of educational technology, endorsed by the rapid and increasingly diffused spread of Information and Communication Technologies (ICTs), represents one of the primary drivers for the transformation of teaching and learning environments and practices (Bilyalova et al., 2019), raising the need for digital literate teachers (Sánchez-Cruzado et al., 2021). Although educational technologies have become increasingly available and affordable for schools, their mere presence in the classroom does not guarantee instant benefits for students' learning outcomes and experience (Benigno et al., 2023; Bocconi et al.,

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2020). If, on one hand, scientific literature underlines the need to investigate accessibility and usability requirements to promote technology as an inclusive didactic mediator (Di Paolo et al., 2023; Cadet et al., 2022; Kye et al., 2021; Reeves et al., 2021; Morganti & Riva, 2006), teachers' knowledge, competences and perceptions is still the main factor that drives (or obstacles) their use (Giaconi et al., 2024; Caldarelli et al., 2023; Giaconi et al., 2023). Consequently, continuing education should address teachers' perceptions and skills in order to effectively train them in responding to contemporary challenges in education. When looking at the contemporary scenario, educational systems are immersed in a Digital Transformation Era (Braga, 2017) that raises the need to acknowledge and understand the advantages and disadvantages of technologies to foster inclusive learning environments as facilitators (Pinnelli & Fiorucci, 2020; WHO, 2001). As ICTs have been spreading across Italian schools due to investments promoting their use (e.g., National Recovery and Resilience Plan, 2022), their meaningful application and integration still poses critical issues from a pedagogical perspective. If the efficacy of ICTs in didactics is primarily connected to teachers' competences and awareness on the use of such tools (Masenya, 2021; Limone et al., 2016; Muscarà & Messina, 2014; Ertmer, 2005; Rogers, 2000), their implementation raises several challenges with reference to concrete and human resources (Haleem et al., 2022). Specifically, scientific literature underlines how teachers' sense of self-efficacy, perception of benefits and the interest related to ICTs might facilitate or obstacle the adoption of innovative approaches and technological tools (Joo et al., 2018; Kent & Giles, 2017; Lemon & Garvis, 2016; Muscarà & Messina, 2014; Ismail et al., 2010, Sugar et al., 2004), In this direction, the influence of factors such as gender and disciplinary background is still to be fully investigated. Such dimensions would then appear to be intrinsically relevant to digital transformation and inclusion. In this sense, fostering digital competences acquires paramount importance for the renewal of educational processes and methodologies, reshaping the frames of reference that orient teacher agency and welcoming ICTs in ordinary didactics. As highlighted by Alférez-Pastor et al. (2023), a fruitful implementation of educational technologies requires not only technical knowledge and competences, but also a renewed sensitivity on teaching methods. Indeed, as teachers are asked to manage hardware and software tools successfully, they should also be able to choose, integrate and adapt the most suitable supports in light of the pedagogical and didactic needs they wish to respond to. Such an approach is often reversed, as the use of mediators for their own sake might prevail on pedagogical perspectives and educational goals (Pinnelli & Fiorucci, 2015). The promotion of such a shift of paradigm in education inevitably calls into question teachers' knowledge, opinions and beliefs on the use of ICTs for education (Eickelmann & Vennemann, 2017), which are directly connected to their willingness and concrete possibilities of integrating technology in didactics (Ismail et al., 2010). For these reasons, understanding the opportunities and obstacles that teachers perceive becomes a primary step to identify how teacher continuous training could be enriched and renewed. In line with previous studies on the topic (Caldarelli et al., 2023; Starkey, 2020; Iommi et al., 2021; Moursund & Bielefeldt, 1999), this paper aims at collecting and analysing the perceptions of teachers in training with reference to the implementation of ICTs for inclusive didactic practices, focusing on the Italian national context. In harmony with the topics of interest of Special Pedagogy and Didactics (Pinnelli & Fiorucci, 2020; Hamburg & Bucksch, 2015; Calvani & Vivanet, 2014), this paper aims at investigating Italian teachers' practices, attitudes and perceptions regarding the use of ICTs within inclusive education processes. Specifically, the research questions (RQs) are the following:

- RQ1: How often do teachers use ICTs in everyday practices?
- RQ2: How do teachers perceive their use of ICTs in relation to self-efficacy, outcome expectation and interest?
- RQ3: Do the factors of gender, school level, disciplinary background, and seniority influence teachers' use of ICTs and perceptions? If so, how?

To answer the RQs, 830 Italian teachers in training were interrogated through the Italian adaptation of the Intrapersonal Technology Integration Scale (ITIS Scale) (Niederhauser & Perkmen, 2008), unveiling the factors that impact the frequency, the skills and the perceived self-efficacy with which teachers implement ICTs in their everyday practices. In this sense, this study can provide original insights on the factors that facilitate or obstacle the use of ICTs in education, unfolding the multidimensional nature of such a topic and contributing to existing literature. Accordingly, the results could offer relevant guidance for the implementation of teacher training paths.

2. Materials and Methods

In line with existing literature on the topic (Benigno et al., 2013; Muscarà & Messina, 2014; Perkmen & Pamuk, 2011; Niederhauser & Perkmen, 2008), the Italian adaptation of the Intrapersonal Technology Integration Scale was used as primary assessment tool (Benigno et al., 2013). The choice of the tool is connected to the topics of interest that it allows to investigate: the concepts of Self-efficacy, Outcome expectation, Interest and Behavioural Intentions on the

didactic use of technologies in learning environments (Sugar et al., 2004).

3.1 Measuring Tool

The Intrapersonal Technology Integration Scale was used as an assessment tool to investigate beliefs and perceptions of teachers on the use of ICTs for inclusive education. The Italian version of the questionnaire, adapted by Benigno et al. (2013), was administered through the Google Form software. The adopted tool is composed of four main sections, with the ITIS scale placed as fourth and last section, as implemented in Muscarà & Messina (2014). The three previous sections allow for the collection of additional data relevant to the analysis. The first section collects anagraphic information on the interviewee (i.e., age, sex, education level, school level they teach in, disciplinary area they teach in, and total years of service). The second section investigates the Frequency of use of didactic technologies made by interviewees in their everyday teaching. Participants are asked to choose between the following answers: Never; A few times a year; A few times a month; A few times a week; Everyday. This section allows the identification of the participants who choose the answer "Never": in this case the questionnaire ends. The third section consists in a series of questions aimed at investigating teachers' proficiency with reference to four items: Tech Tools (e.g., computer, DVD player, Interactive Whiteboard); PC Apps (eg., Microsoft Word, Microsoft Excel, Microsoft PowerPoint); Internet Apps (e.g., e-mails, websites); Collaborative Writing Softwares (CollSW) (e.g., Google Docs). For each item, participants can indicate their level of proficiency through a 5 point Likert scale (where 1 corresponds to "No competences" and 5 corresponds to "Excellent level"). The fourth and last section consists in the Italian version of the ITIS Scale, composed of 21 items to be assessed through a 5 point Likert scale (1 = "Strongly disagree", 5 = "Strongly agree"). The Scale investigates the following factors:

- *Self-Efficacy* (SE): the level of self-efficacy and confidence that teachers perceive when using ICTs in the classroom (6 items);
- *Outcome Expectation* (OE): the perception of potential benefits related to ICTs implementation, divided in *Social Outcome Expectations* (SOE), *Self Evaluation Outcome Expectations* (SEOE) and *Performance Outcome Expectations* (POE) (9 items);
- *Interest* (INT): teachers' willingness to integrate ICTs in didactic activities (6 items).

3.2 Participants

Participants sample is composed of 830 Italian teachers working at any school level, attending the 30 credits Training (Decree Law n.59/2017; Prime Ministerial Decree of 4 August 2023). Participants were recruited on a voluntary basis through an online form. Participants' age ranges between 24 and 61 years (M = 45.24; SD = 7.804), with a service age between 0 and 38 years (M = 11.63; SD = 6.998). The sample consists of 610 (73.5%) females and 220 (26.5%) males. Among these, 524 (63.1%) declare to possess a postgraduate qualification (e.g., specialisation or PhD). Figure 1 shows the distribution of teachers with reference to their disciplinary area, while Figure 2 shows the school level they work at. As we can see, the majority of teachers work in scientific disciplines (38.9%). With reference to school level, the vast majority of teachers work in secondary schools (87.7%).

Figure 3 shows the relationship between usage of ICTs and disciplinary area, while Figure 4 shows the relationship between usage of ICTs and school level. Only 5 participants out of the total sample declared to have never used ICTs in teaching. Additionally, 17 participants did not complete the ITIS Questionnaire. These participants were excluded from the analysis.

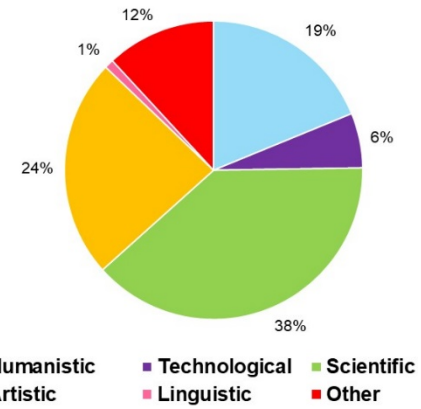
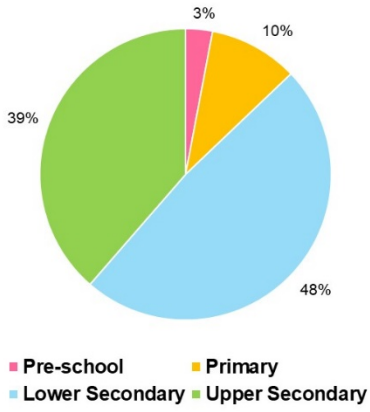


Figure 1 - Distribution of disciplinary areas.



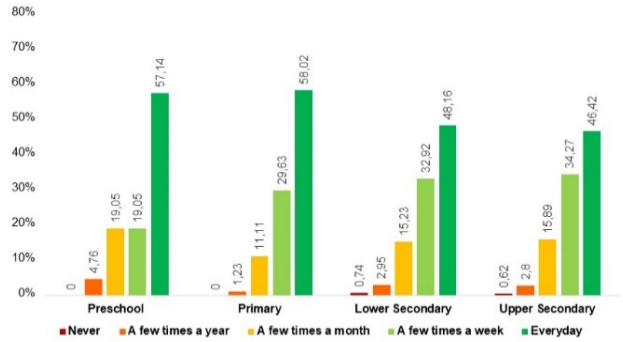


Figure 3 - Relationship between usage of ICTs and disciplinary area.

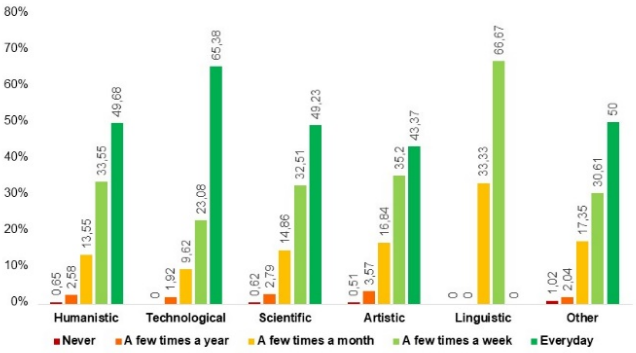


Figure 4 - Relationship between ICTs usage and school level of teaching.

3.3 Data Analysis

Data analysis focused on the answers provided by the 808 participants who completed the questionnaire. Data analysis was carried out through the software SPSS v20. Alpha Cronbach Index was extracted to assess the reliability of each factor, with successful results (Alpha Chronbach: SE = 0.909; INT = 0.893; OE = 0.838; POE = 0.829; SOE = 0.907; SEOE = 0.881). For each participant, SE, INT and OE results (as well as POE, SOE and SEOE) were calculated through the mean of the expressed evaluation for every item.

Based on the results of the Shapiro-Wilk tests that were conducted, none of the distributions of the collected data with respect to the metric variables considered (SE, OE, POE, SOE and SEOE, levels of proficiency with the various technologies) were normal ($p < 0.001$). Accordingly, nonparametric tests were used to test the effect of the various factors of interest on the variables considered. In particular, the Mann-Whitney U-test was used to investigate the effect of the factor "gender" on the variables of interest (teachers' perceptions of their own technological competence, SOE, OE, POE, SEOE, and INT). To explore the differences in the other considered factors (disciplinary area, school level, frequency of use of educational technologies) regarding the variables of interest, the Kruskal-Wallis H-test was used. Finally, Kendall's Tau correlation coefficient was used to explore the relationships between the factors of age, seniority and the variables of interest.

3. Results

For the sake of brevity, this section illustrates the most relevant results emerging from the collected data in light of the study focus defined through the RQs.

In the first place, Mann-Whitney U-tests show a statistically significant difference between males and females on TechTools proficiency ($U = 55884.500$, $p = .004$) and CollSW ($U = 56523.500$, $p = 0.012$). Additionally, they show statistically significant differences between males and females on SE factors ($U = 55386.500$, $p = 0.005$) and SOE factors ($U = 55418{,}000$, $p = 0.005$). As Table 1 shows, proficiency levels indicated by male participants with TechTools and CollSW proficiency, as well as the perceived levels of Self-Efficacy (SE) and Social Outcomes Expectations (SOE). No significant differences were found between male and female participants with references to other items. Kruskal-Wallis H-tests show statistically significant differences between groups of participants teaching at different school levels on the perceived proficiency level with PCApp ($\chi 2(df=3) =$

25.532, $p < 0.001$), InternetApp ($\chi2(df=3)= 10.774$, $p = .013$) and CollSW ($\chi2(df=3)= 21.894$, $p < .001$). Dunn's test for pairwise multiple comparisons highlights statistically significant differences between primary school teachers and lower secondary school ones, as well as between primary school teachers and upper secondary school ones. In all cases, perceived proficiency on PCApp, InternetApp and CollSW use are higher in secondary school teachers compared with primary school ones. Table 2 illustrates such results.

Kruskal-Wallis H-tests show how the factor "disciplinary area of teaching" has a statistically significant effect on SE ($\chi2(df=5)=22.507$, $p < .001$), TechTools ($\chi2(df=5)=35.055$, $p < .001$), PCApp ($\chi2(df=5)= 41,494$, $p < .001$), InteretApp ($\chi2(df=5)= 20.640$, $p = .001$) and CollSW ($\chi2(df=5)=22.991$, $p < .001$).

Figure 5 illustrates the results of each disciplinary area with reference to the mentioned items. Results show how teachers of Humanistic disciplines attest to lower levels of proficiency in the use of TechTools compared to those belonging to the Technological, Scientific or Artistic fields. On the other hand, teachers of Technological disciplines claim the highest levels of proficiency in this field. Similarly, with reference to PCApp proficiency, Humanistic disciplines teachers attest the lowest levels of proficiency, while Scientific and Technological disciplines teachers claim the highest ones. Considering InternetApp, humanistic disciplines teachers still present the lowest levels of perceived proficiency. In CollSW proficiency, teachers of humanistic disciplines attest the lowest levels, while those of technological disciplines claim the highest ones. Lastly, teachers of technological disciplines showed the highest levels of SE compared to teachers of the other areas. No statistical differences were found in the assessment of OE, POE, SEOE, SOE and INT levels.

Lastly, correlations between age and seniority with reference to the analysed factors shows that there is no statistically significant correlation +between the Frequency of use of didactic technologies and age or seniority of participants. However, it appears that the perceived proficiency levels on the use of TechTools, PCApp, InternetApp and CollSW are negatively correlated with age and seniority (although mildly, since all correlation coefficients are below 0.3) with statistical significance. Similarly, a mild but statistically significant negative correlation between participants' age and SE and INT factors was assessed ($r < 0.3$).

Table 1 - Results of statistically significant indicators between sex-differentiated groups.

	Sex	Numerosity	Mean	SD	Average rank
TechTools	F	594	4,07	0.753	391.58
	M	214	4,24	0.695	440.36
CollSW	F	594	3,51	0.994	392.66
	M	214	3,73	0.889	437.37
SE	F	594	3,55	0.750	390.743
	M	214	3,71	0.728	442.685
SOE	F	594	2,61	1.072	390.796
	M	214	2,85	1.135	442.537

Table 2 - Results of school level comparisons.

	Sample1-Sample 2	Test statistics	Std error	SD test	p
PCApp	Primary-Lower secondary	-123.141	26.204	-4.699	.000
	Primary-Upper secondary	-120.680	26.843	-4.496	.000
InternetApp	Primary-Lower secondary	-77.932	25.858	-3.014	.015
	Primary-Upper secondary	-78.156	26.489	-2.951	.019
CollSW	Primary-Lower secondary	-126.403	27.124	-4.660	.000
	Primary-Upper secondary	-103.801	27.786	-3.736	.001

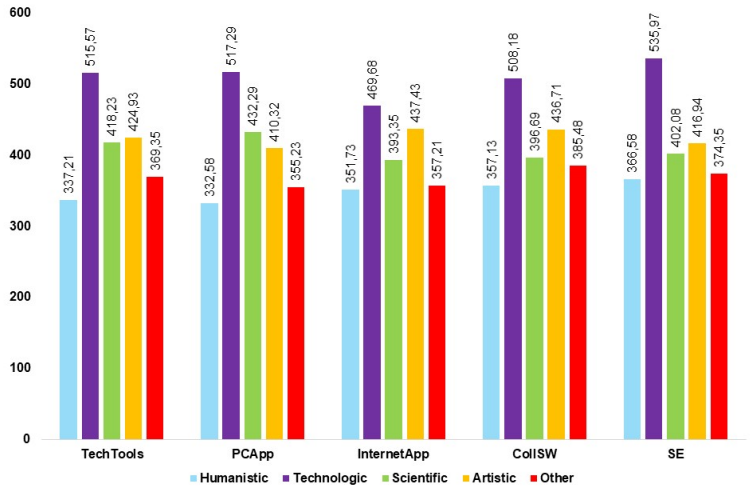


Figure 5 - Average rank across disciplines.

4. Discussion and Conclusions

When looking at the main results collected from this analysis, the first aspect that emerges is related to differences in perceived proficiency and self-efficacy on the use of ICTs based on participants' gender. As male participants claim higher levels of perceived proficiency and self-efficacy, female participants show lower levels in these areas, also with reference to the SOE factor. As such results confirm existing literature on the topic (Mariscal et al., 2019; Gudmundsdottir & Hatlevik, 2017; Muscarà & Messina, 2014; Jimoyiannis & Komis, 2007), it appears relevant to reflect upon the factors which this gap could stem from. EU's 2022 Women in Digital Scoreboard underlines how educational backgrounds influence the acquisition of specialist digital skills among people. Indeed, ICT specialists and graduates in STEM are almost entirely male. Additionally, the gender gap in digital skills grows with the increase of complexity of such digital skills according to the Report, meaning that the gap is smaller when considering internet user skills or basic digital skills. EU data could provide an explanation to our results, considering how the application of ICTs in teaching practices would reasonably require a higher level of proficiency than basic digital skills. With reference to the Italian context, national data confirm the European tendencies, proving how academic careers in STEM areas are less pursued by female students, evidencing a consistent gender gap (ISTAT, 2021). Kuroda et al. (2019) recognise how the gender gap in digital skills includes a relationship between the access to digital technologies and the development of the skills that allow to design, develop and make use of them. In this sense, the mere access to ICTs does not guarantee women the agency and competences to successfully leverage such access, as they miss the opportunity to successfully implement them in their everyday lives (Mariscal et al., 2019). However, it is still important to acknowledge that the results obtained for self-efficacy levels do not necessarily imply that males are effectively more capable of using ICTs, as they could be over-reporting their skills (Gudmundsdottir & Hatlevik, 2017).

The school level within which teachers work appears to constitute another relevant factor influencing the use of ICTs. Specifically, secondary school teachers tend to perceive a higher level of proficiency compared to primary school or preschool teachers. Such results, which are consistent with existing literature (Tzafilkou et al., 2023), could suggest how the different paths of teacher training, specialisation and continuing education for each school level might impact teachers' familiarity and perceived proficiency with ICTs application in didactics (Benigno et al., 2023; Hennessy et al., 2005). The need to foster primary school teachers' digital skills appears relevant when considering how young learners have the opportunity to develop digital skills in informal scenarios (Pérez-Escoda et al., 2016). As highlighted by Alférez-Pastor et al.'s review (2023), training programs should consider the pedagogical aspects of implementing ICTs in the classroom, and not only technical issues. In fact, research highlights how primary school teachers risk lacking the skills to implement such technologies in everyday teaching (Stringer et al., 2022; Perifanou et al., 2021). These considerations align with the strategic trajectories identified by the Italian Ministry of Education (Ministerial Decree of 14 June 2022).

Disciplinary fields appear to represent a significant factor in determining the relationship between teachers and ICTs use in the classroom. Confirming the results of previous research on the topic (Muscarà & Messina, 2014), teachers belonging to STEM disciplines claim to possess the highest levels of proficiency in use and self-efficacy perceptions. Conversely, teachers that

work within humanistic disciplines show lower levels of competences and self-efficacy. It appears reasonable to partially explain this difference by acknowledging how teachers in the STEM area might have been trained on ICTs more thoroughly, having more opportunities to familiarise with their use (Muscarà & Messina, 2014; Hennessy et al., 2005). Although ICTs proficiency varies across STEM subjects and contexts (Vieira et al., 2023), literature confirms how STEM teachers tend to perceive themselves as more competent in ICTs use compared to other domains, claiming to use them often and seeing more potential benefits in their application (Zubkovic et al., 2022). Although ICTs can enhance students' learning in humanities disciplines as well (Scolaro, 2020; Ni, 2012), existing research confirms how non-STEM teachers lack confidence and skills in implementing them (Adu & Zondo, 2023; Ray et al., 2020), highlighting the need to foster support and digital training.

Lastly, the correlations between age, seniority and ITIS factors should be considered. The analysis' findings illustrate how the perception of self-efficacy and the interest towards technologies seems to decrease with the increase of participants' age. Similarly, a negative trend can be found in the correlation between seniority and self-efficacy, interest and outcome expectations. Such findings reflect existing literature, illustrating how younger teachers show higher levels of proficiency with digital tools (Mortis et al., 2013; Suàrez-Rodriguez et al., 2012). Such a result underlines the centrality of teacher training in technology-supported teaching to allow continuous education, as older adults might have had less opportunities to experience new technologies compared to digital natives, consequently facing barriers of various kinds (Bhattacharjee et al., 2021; Hargittai et al., 2019). In this context, teacher training is the only vehicle through which they can approach the latest advances of ICTs, learning how to make use of them in their teaching practices.

In conclusion, the results obtained by the present work, in light of the research questions, draw attention to the needs that should be addressed by initial and continuing education programs in order to strengthen teachers' knowledge and skills on the didactic use of ICTs. Specifically, with reference to RQ1, the study highlights how disciplinary fields play a central role in the frequency of use of ICTs in education. With reference to RQ2 and RQ3, perceptions regarding self-efficacy, outcome expectations and interest appeared to be considerably impacted by factors such as gender, school level, disciplinary fields and seniority. Further into detail, the results evidenced a significant gender gap in the perceived self-efficacy of ICTs favouring male teachers in comparison with female teachers. With regards to school levels, secondary school teachers showed higher levels of proficiency and confidence in the use of ICTs compared to primary and preschool teachers. Disciplinary fields appeared as another relevant factor in the perception and use of ICTs, proving how teachers belonging to the STEM area are more likely to feel confident in their application. Lastly, the level of seniority and teacher's age appeared to negatively impact self-efficacy, outcome expectations and interest in the use of ICTs. In this sense, disparities across teachers of different gender, age, school level or disciplinary field influence the perceptions on ICTs use in education. As ICTs become increasingly embedded within daily activities, theoretical and practical knowledge on education should embrace their integration, providing pre-service and in-service teachers with the opportunity to understand their practical use and pedagogical implications. International research confirms how teacher training is central for the acquisition of such didactic and methodological competences, underlining the role of policies in giving value to such a topic (Gil-Flores et al., 2017). Accordingly, educational institutions should encourage the acquisition of digital teaching competences, addressing the need to continuously update teachers' practices. If teachers lack sufficient digital skills (Chandrasena, 2019; Nowak, 2019), the didactic use of ICTs in everyday teaching practices risks being limited, and its potential mostly unexploited (Escudero et al., 2019). In this context, initial and continuing education programs for specialised teachers provided by Italian universities provide a viable opportunity to renew teacher training programs and promote an informed use of technologies in education, benefitting from their potential to support personalization of didactic, inclusive processes and learners' active participation, discovering innovative learning resources that could increase the quality of education (UN, 2015). As the use of ICTs directly reflects teachers' beliefs and pedagogical attitudes (Loveless & Ellis, 2001), teacher training should focus not only on the acquisition of practical skills for the integration of ICTs, but also on motivation and perceived value of such tools (Giaconi et al., 2019; Muscarà & Messina, 2014). Accordingly, it should encourage teachers to perceive their agency and protagonism in the technological landscape, creating innovative content and sharing best practices. This study highlights how existing teaching training should be improved to foster digital competences across teachers and fill gaps related to gender, disciplinary field of teaching or age. Future lines of research should dive deeper into the understanding of internal and external motivations linked to the choice of implementing ICTs in didactic practices with reference to different contexts and educational stages. As a result, meaningful trajectories for the design of effective teacher training paths could be identified, reshaping the educational system's methods and tools starting from the needs of learners in these times of constant change and rapid evolution of technologies

(Giaconi et al., 2023). If teachers have the responsibility and mandate to inhabit the forefront of educational processes as main drivers to promote inclusion, innovation and students' wellbeing in the classroom (Larsen, 2010), fostering their professional growth represents a key trajectory to support the renovation of educational systems in the Digital Transformation Era.

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