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EDITED BY
Klaus Zierer,
Independent Researcher, Augsburg, Germany

REVIEWED BY
Stephan Wernke,
University of Oldenburg, Germany
Ewald Kiel,
Ludwig Maximilian University of Munich, Germany

*CORRESPONDENCE
Sara Peretti
✉ sara.peretti@guest.univaq.it

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#InstaMind: teachers' beliefs on educational technology to promote seamless technology integration in early education

Sara Peretti[1]*, Milan Kubiatko[2], Federica Caruso[3], Tania Di Mascio[3], Marco Giancola[4], Simonetta D'Amico[4] and Maria Chiara Pino[4]

[1]Center of Excellence DEWS, University of L'Aquila, L'Aquila, Italy, [2]Faculty of Education, Department of Preschool and Primary Education, J. E. Purkyne University, Ústí nad Labem, Czechia, [3]Department of Information Engineering, Computer Science and Mathematics, University of L'Aquila, L'Aquila, Italy, [4]Department of Biotechnological and Applied Clinical Sciences, University of L'Aquila, L'Aquila, Italy

Background: The digital revolution has deeply affected every aspect of our daily lives, including education, transforming how we learn and teach. In Italy, this transformation has occurred naturally for the alpha generation, born in the era in which technology is an integral part of their education. Conversely, for teachers who are not digital natives, adapting to this technological era is a considerable challenge. This challenge is increasing for Italian teachers working with preschoolers. Indeed, prior to the COVID-19 pandemic, such technologies were sparsely utilized within early education. This study aims to explore Italian teachers' beliefs through internal factors—i.e., self- efficacy, outcome expectations, and interest, toward the integration of educational technology in teaching.

Methods: To this end, the standardized Intrapersonal Technology Integration Scale was selected to measure the Italian teachers' beliefs. The study includes 180 teachers working with the alpha generation, which encompasses children currently attending pre-kindergarten, kindergarten, and primary education.

Results: The results obtained from the comparison among the three groups of teachers (pre- kindergarten, kindergarten, and primary education) on the internal factors are manifold. Mainly, although all teachers are interested in educational technologies, there is a reluctance and low self-efficacy perception to use them with preschoolers. Specifically, pre-kindergarten teachers perceive themselves as less effective and satisfied using such technologies than kindergarten and primary teachers. Moreover, greater teachers' age and greater teaching experience predict a lower level of perceived self-efficacy and outcome expectations, highlighting resistance toward technological change. All results and their implications are detailed in this text.

Discussion: This study suggests focusing on perceived self-efficacy, offering customized training to enhance it, exploiting the teachers' interest, enriching teachers' knowledge through scientific dissemination seminars, and using an effective method. To conclude, understanding teachers' beliefs is a challenge to better meet the needs of the digital-native generation and harness the potential of educational technologies in childhood education.

KEYWORDS

beliefs, educational technology, preschoolers, self-efficacy, teachers, alpha generation

1 Introduction

Today, we are experiencing a true digital revolution: every aspect of our lives, from having a coffee to sending an email, is permeated by the use and influence of information and communication technologies. The impact of these technologies is powerful in formal educational contexts, foremost among them being schools, where they are known as educational technologies and defined as complex and integrated processes that involve individuals, ideas, organization, and tools (such as educational software and interactive whiteboards) to promote learning and teaching (Benigno et al., 2013; Mazza et al., 2014; Ghavifekr and Rosdy, 2015; Grassini, 2023). Indeed, over the past 20 years, the school has undergone a substantial digital transformation in which educational technologies have facilitated the creation of self-regulated, individualized, and interactive learning models (Dettori and Persico, 2010; Mooij et al., 2014; Jin et al., 2023; Junastikova, 2023). Furthermore, traditional learning paradigms have been partially replaced by dynamic and flexible paradigms based on new methodologies such as distance learning, mobile learning, and flipped classrooms (Haleem et al., 2022; Jin et al., 2023; Lopez, 2023). This progressive digital transformation of schools experienced an unprecedented rush due to the COVID-19 pandemic, which imposed severe restrictions related to social distancing needs. National lockdowns affected nearly 70% of the global student population (Benigno et al., 2022; UNESCO International Commission on the Futures of Education, 2022).

In Italy, the Decree-Law February 23, 2020, no. 6 (2020) mandated the gradual closure of all levels of schools. Thus, education was made possible only through a technological mediation, i.e., distance learning. Consequently, the Italian education system and, therefore, teachers have been severely challenged by technology, which was rapidly integrated into every aspect of teaching activities. Naturally, this integration has not been, and still is not, straightforward (Giovannella et al., 2020; Benigno et al., 2022). Furthermore, an additional challenge is that due to COVID-19, educational technologies forcefully asserted themselves in Italian early childhood education, which had previously a limited use compared to the utilization/use of technologies in higher education (Zecca, 2021; Alves et al., 2022; Sutiyono et al., 2022; Bosoni, 2024). The last consideration, coupled with an educational system in constant technological dynamism, has brought attention to the inherent disparity between the alpha generation, encompassing children born in the last approximately 10 years, and teachers, who can be defined as digital immigrants since they adopted technology later in their lives and not from birth (Prensky, 2001).

Specifically, on the one hand, the alpha generation seems to be inherently equipped with a technological knowledge base from birth, while on the other hand, teachers appear to be "technologically illiterate" as they pursue technological knowledge through specific training courses (Lawall and Pietrocola, 2017; Molina, 2021). Furthermore, for the alpha generation, the integration of technologies in various aspects of life, including education, occurs naturally; on the contrary, for teachers, such integration faces at least two challenges (Admiraal et al., 2017; Masoumi, 2021). The first challenge is linked to the Italian education system and concerns different problems regarding economic resources, adaptation of spaces, lack of time to use technology during the lessons/in the classrooms, and technological support in schools; this is the interpersonal dimension linked to external factors (Brzycki and Dudt, 2005; Buabeng-Andoh, 2012; Khukalenko et al., 2022; Gkrimpizi et al., 2023). Instead, the second challenge is related to the teachers' beliefs, who often do not perceive themselves as adequate educators when they use technology; this is the intrapersonal dimension that is linked to internal factors (Del Gobbo et al., 2022; Alenezi et al., 2023; Mhlongo et al., 2023), which would seem to play the most impactful role in the possibility of integrating educational technologies at school (Niederhauser and Perkmen, 2008; Benigno et al., 2014).

In this regard, the literature provides heterogeneous evidence due to the differences in educational systems (for instance, Italian, English, Romanian etc.) and in teacher training paths. Nevertheless, there is consensus in recognizing the crucial role of three internal factors in affecting teachers' belief toward integrating technology into their teaching (Niederhauser and Perkmen, 2008; Buabeng-Andoh, 2012; Zeng et al., 2022; Gkrimpizi et al., 2023). The first internal factor is self-efficacy, which is the judgment of one's ability to effectively use computer devices (Hackett et al., 1994). This judgment influences teachers' commitment and satisfaction toward technologies (Wang et al., 2004; Gilakjani, 2013; Zhao and Zhao, 2021; Azizi et al., 2022). The second internal factor is outcome expectation, which is closely linked to the concept of self-efficacy. Indeed, while self-efficacy refers to the belief in one's abilities to enact a course of action to achieve predetermined levels of performance, outcome expectation guides personal judgment about the likely consequences/results that such actions will produce (Bandura, 1986; Darling-Hammond et al., 2020; Twohill et al., 2023). These two important mechanisms of human behavior play a fundamental role in positively directing motivation and interest in every individual. Self-efficacy and outcome expectation are closely correlated with a third internal factor: interest. The interest factor appears to be central in implementing goal-directed behaviors; individuals especially show interest in those activities where they judge themselves as effective and envision positive outcomes (Reynolds, 2000; Sukkamart et al., 2023).

Despite the significant role of internal factors, most studies have focused on external factors that can be improved by providing resources for infrastructure, professional development, and a strong support system. These measures are often implemented through administrative and structural changes (Niederhauser and Perkmen, 2008; Del Gobbo et al., 2022; Alenezi et al., 2023; Mhlongo et al., 2023). External factors are necessary conditions but they are not sufficient to promote the integration of educational technologies at school (Niederhauser and Perkmen, 2008; Benigno et al., 2014). On the contrary, internal factors are sufficient conditions to promote technology integration because they also tend to act as mediators for many other external factors (Albion and Ertmer, 2002; Niederhauser and Perkmen, 2008; Dignath et al., 2022).

Therefore, addressing internal factors is more crucial, especially in the post-COVID-19 era, where the growing technology gap between the alpha generation and the teachers has underscored their increasing relevance. In fact, the importance of internal factors has become particularly evident following the unprecedented adoption of educational technologies in Italian schools of all levels.

Notwithstanding that, addressing them is also more complex since they are often related to teachers' beliefs, which are difficult to measure (Hackett et al., 1994; Dignath et al., 2022). In fact, these beliefs reflect experiences and personal characteristics influencing an individual teacher's predisposition (Hackett et al., 1994; Dignath et al., 2022).

An initial key step to consider these internal factors involves adequately measuring them to establish a baseline of teachers' beliefs toward integrating technology into their educational activities. The present study goes in this direction by measuring the Italian teachers' beliefs toward integrating educational technology into their teaching. Specifically, this study aims to investigate the beliefs of Italian teachers working with the alpha generation, currently working in pre-kindergarten, kindergarten, and primary education, through a self-report Questionnaire, namely "*School and Education Technologies*," regarding the integration of educational technologies in their teaching activities. The research question that drives our study is: *What are Italian teachers' beliefs regarding the integration of educational technologies in their daily classroom activities with children attending pre-kindergarten, kindergarten, and primary education?*

2 Materials and methods

2.1 Participants

The study was conducted on a total sample of 180 teachers, 177 females and 3 males (1 male at pre- kindergarten and 2 males in primary education), evenly distributed across the northern, central, and southern regions of the Italian peninsula. The total sample of 180 teachers was unbalanced among pre-kindergarten (38 = 21.1%; *asilo nido*: from 3 months to 3 years), kindergarten (49 = 27.8%; *scuola dell'infanzia*: from 3 to 6 years), and primary education (93 = 51.1%; *scuola elementare*: from 6 to 10 years) teachers.

In the pre-kindergarten sample, 81.6% (31) work in public schools, while 18.4% (7) of them work in private schools. In the kindergarten sample, 83.7% (41) work in public schools, while 16.3% (8) of them work in private schools. Finally, In the primary education sample, 92.5% (86) work in public schools, while 7.5% (7) of them work in private schools.

No significant differences in mean age among pre-kindergarten (mean age ± SD:44.89 ± 11.91), kindergarten (mean age ± SD:44.91 ± 7.94) and primary education (mean age ± SD:44.58 ± 11.19) were found ($F_{2,178} = 0.02$; $p = 0.97$; $\eta^2 = 0.05$).

No significant differences in the mean teaching experience among pre-kindergarten (mean age ± SD:16.01 ± 12.43), kindergarten (mean age ± SD:13.49 ± 8.25) and primary education (mean age ± SD:13.24 ± 10.81) were found ($F_{2,178} = 0.97$; $p = 0.38$; $\eta^2 = 0.33$).

2.2 "School and Educational Technologies" questionnaire

To verify the research question (i.e., *What are Italian teachers' beliefs towards integrating educational technologies in their daily classroom activities with children attending pre-kindergarten, kindergarten, and primary education*?), a self-report questionnaire, i.e. "School and Educational Technologies", was proposed. This questionnaire consists of two sections:

- Section A: Awareness and Experience. This section was proposed to gather socio-demographic information about our sample and collect data regarding teachers' awareness about educational technologies. Additionally, we included questions to assess teachers' perspectives on using educational technologies with preschool children.
- Section B: Intrapersonal Technology Integration Scale-Italian version (ITIS; Niederhauser and Perkmen, 2008; Benigno et al., 2013). The ITIS was developed by Niederhauser and Perkmen (2008) to investigate the role played by teachers' beliefs in integrating technology in the classroom. Specifically, the ITIS scale is designed for teachers at all levels of education to measure their beliefs regarding the perceived level of self-efficacy and their outcome expectations concerning the use and integration of educational technologies in their daily teaching practices.

The conceptual framework is derived from the Social Cognitive Career Theory (Hackett et al., 1994), whose fundamental mechanisms are based on the concepts of Self-Efficacy (SE), Outcome Expectation (OE), and Interest (INT). The ITIS Scale-Italian version takes the form of a self- assessment questionnaire consisting of 21 items aimed at evaluating the factors of the Social Cognitive Career Theory across three subscales: Self-Efficacy (6 items), Outcome Expectation (9 items), Interest (6 items). For each item, participants are required to indicate their level of agreement or disagreement on a five-point Likert scale: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), strongly agree (5). The items related to the Self-Efficacy subscale measure the individual's perceived confidence level in using educational technologies in the classroom. The Interest subscale is utilized to gauge teachers' interest in incorporating educational technologies into their teaching. The Outcome Expectation (OE) subscale assesses beliefs regarding the benefits of using educational technologies in the classroom. OE subscale includes three dimensions:

- *Performance Outcome Expectations (POE)* that represent the belief that using technologies in the classroom could make a teacher's instructional actions more effective.
- *Self-Evaluative Outcome Expectations (SEOE)* that represent the belief regarding the personal satisfaction that a teacher might experience by using technologies in the classroom.
- *Social Outcome Expectations (SOE)* that represent the belief that colleagues would view positively the use of technologies in teaching processes.

The Italian version of the ITIS scale is available as a paper version and a fillable online version, along with the corresponding normative tables for score attribution (for details, see Benigno et al. (2013). This study used only the online version integrated into the "School and Educational Technologies" questionnaire implemented on Google Forms. The ITIS-Italian version showed good reliability and internal consistency (Cronbach's $\alpha = 0.94$). Likewise, good reliability and internal consistency were obtained from the Cronbach's α analysis performed on the sub-scales of ITIS separately: Self-Efficacy (Cronbach's $\alpha = 0.92$), Interest (Cronbach's $\alpha = 0.89$) and Outcome Expectation resulting from its three dimensions, i.e., Performance Outcome Expectations $\alpha = 0.82$), Self-Evaluative Outcome Expectations (Cronbach's $\alpha = 0.85$) and Social Outcome Expectations (Cronbach's $\alpha = 0.90$).

3 Data analysis

To analyze the data collected through the "School and Educational Technology" questionnaire, the following data analysis was conducted:

- Frequency analysis was performed on Section A of the "School and Educational Technologies" Questionnaire: Awareness and Experience to provide an overview of teachers' profiles.
- One-way ANOVA and the post-hoc analysis were performed on Section B of the "School and Educational Technologies" Questionnaire: Intrapersonal Technology Integration Scale-Italian version to test differences among groups (Pre-kindergarten Teachers, Kindergarten Teachers and Primary Education Teachers) on subscales of ITIS.
- Correlation analysis (Pearson's correlation) was performed to explore the presence of significant relationships between the subscales of ITIS, years of teaching experience and teachers' age.
- Regression analysis was performed to evaluate the causal relations between the dependent variable and the independent variables. In this study, the variables for the regression analysis were the components of the ITIS scale (SE, OE and INT), years of teaching experience and teachers' age.

The study follows the Journal Article Reporting Standards (JARS) for quantitative research (JARS- Quant) (APA Publications, 2008). All the continuous variables were normally distributed with skewness between −1 and 1. The homogeneity of variance was checked for all parametric tests. All multiple comparisons were Bonferroni-adjusted ($p \leq 0.05$). The overall statistical significance of the model was set at the 0.05 level. The Statistical Package for the Social Sciences (SPSS) software (version 22; SPSS Inc., Chicago, IL, USA) was used.

3.1 Results

3.1.1 Frequency analysis

Frequency analysis was performed to provide an overview of teachers' profiles within our sample regarding their awareness of educational technologies and some opinions on using such technologies with preschool children. The results are reported below based on the kind of questions. The six answers collected on a dichotomous scale are reported in the bar chart in Figure 1.

Instead, the only question with six possible answer alternatives is given below:

- In your opinion, at what age should a child start using technology?
- Answers from the sample of pre-kindergarten teachers: From birth (0%),1 year (5.3%), 2 years (5.3%), 3 years (0%), 4 years (18.4%), 5 years (71.1%), and after 6 years (0%).
- Answers from the sample of kindergarten teachers: From birth (6.1%),1 year (4.1%), 2 years (0%), 3 years (8.2%), 4 years (20.4%), 5 years (61.2%) and after 6 years (0%).
- Answers from the sample of primary education teachers: From birth (0%),1 year (2.2%), 2 years (3.2%), 3 years (18.3%), 4 years (30.1%), 5 years (46.2%) and after 6 years (0%).

3.1.2 One-way ANOVA and the post-hoc analysis

One-way ANOVA was used to test differences among groups (Pre-kindergarten Teachers – PkT, kindergarten Teachers – KT, and Primary Education Teachers – PET) regarding the three subscales of the ITIS (i.e., Self- Efficacy (SE), Interest (INT) and Outcome Expectation (OE)). OE involves three dimensions: Performance Outcome Expectations (POE), Self-Evaluative Outcome Expectations (SEOE), and Social Outcome Expectations (SOE).

As shown in Table 1, the results revealed statistically significant differences among the three groups for SE ($F_{2.178} = 5.77$; $p = 0.004$; $\eta^2 = 0.86$), POE ($F_{2.178} = 3.56$; $p = 0.03$; $\eta^2 = 0.65$), SEOE ($F_{2.178} = 5.02$; $p = 0.008$; $\eta^2 = 0.81$) and SEO ($F_{2.178} = 3.45$; $p = 0.03$; $\eta^2 = 0.64$) dimensions of the Outcome Expectation subscale. No statistically significant difference for the INT ($F_{2.178} = 1.62$; $p = 0.20$; $\eta^2 = 0.34$) subscale of the ITIS scale was found.

Specifically, the post-hoc analysis (Bonferroni-corrected) showed the presence of significant differences regarding the score obtained in the SE subscale of ITIS among the pre-kindergarten teachers and primary education teachers (PkT < PET: $M_{diff} = -0.51$; SE = 0.15; $p = 0.003$). No difference, however, was found in the perceived efficacy of using educational technologies in the classroom between pre-kindergarten and kindergarten teachers, as well as between kindergarten and primary education teachers. Moreover, regarding the scores obtained in the POE dimension of the OE subscale of ITIS, the results showed the presence of significant differences among the pre-kindergarten teachers and primary education teachers (PkT < PET: $M_{diff} = -0.44$; SE = 0.16; $p = 0.02$). No significant difference, however, was found in the scores between pre-kindergarten and kindergarten, as well as between kindergarten and primary education teachers.

Regarding the scores obtained in the SEOE dimension of the OE subscale of ITIS, significant differences were found among the pre-kindergarten teachers and both kindergarten (PkT < KT: $M_{diff} = -0.50$; SE = 0.20; $p = 0.04$) and primary education (PkT < PET: $M_{diff} = -0.57$; SE = 0.18; $p = 0.005$) teachers. On the contrary, there is no significant difference between kindergarten and elementary school teachers.

Significant differences were found in the scores of the SOE dimension of the OE subscale of ITIS among pre-kindergarten and primary education (PkT < PET: $M_{diff} = -0.49$; SE = 0.18; $p = 0.02$) teachers. On the contrary, there is no significant difference between pre-kindergarten and kindergarten, as well as between kindergarten and elementary school teachers.

Finally, regarding the scores obtained in the INT subscale of the IT IS, no significant differences were found among the three groups. For details, see Table 1.

3.1.3 Correlation analysis

Pearson's correlation analysis was performed separately for the three groups (PkT, KT, and PET) to explore the presence of significant relationships between the subscales of the ITIS (SE, OE and INT), years of teaching experience and teachers' age.

- Regarding the Pre-kindergarten sample, no significant correlations between the subscales of ITIS and both years of teaching experience and teachers' age were found.

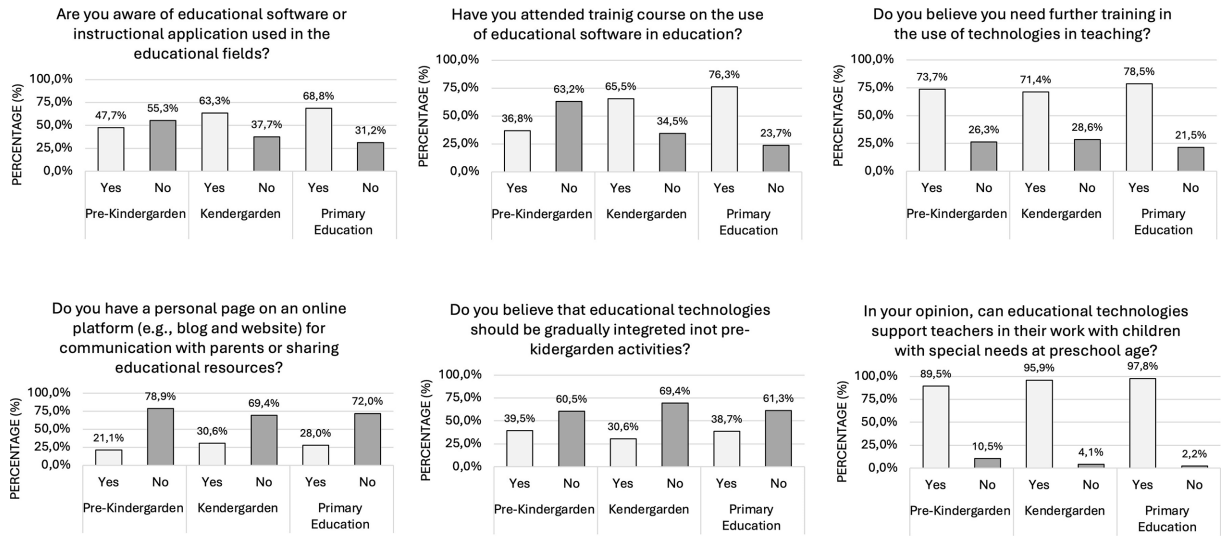

FIGURE 1
Results of frequency analysis performed on Section A of the "School and Educational Technologies" questionnaire to provide an overview of teachers' profiles.

TABLE 1 The post-hoc comparisons among the three groups of teachers (PkT, Pre-kindergarten Teachers; KT, Kindergarten Teacher, and PET, Primary Education Teachers) regarding the three sub-scales of the ITIS [i.e., Self-Efficacy (SE), Interest (INT), and Outcome Expectation (OE)].

ITIS Scale	Groups	Mean (S.D.)	Post-hoc comparison		
			$Mean_{diff}$ (ES)	$Mean_{diff}$ (ES)	$Mean_{diff}$ (ES)
			PkT vs. KT	PkT vs. PET	KT vs. PET
Self-Efficacy (SE)	PkT	2.41 (0.78)	−0.31 (0.17)	−0.51 (0.15)*	−0.19 (0.13)
	KT	2.73 (0.81)			
	PET	2.92 (0.78)			
Interest (INT)	PkT	3.46 (0.91)	−0.24 (0.17)	−0.27 (0.15)	−0.07 (0.16)
	KT	3.70 (0.79)			
	PET	3.73 (0.76)			
Outcome Expectation (OE)					
Performance Outcome Expectations (POE)	PkT	2.96 (0.87)	−0.23 (0.19)	−0.44 (0.16)*	−0.20 (0.15)
	KT	3.20 (0.97)			
	PET	3.41 (0.83)			
Self-Evaluative Outcome Expectations (SEOE)	PkT	2.67 (1.02)	−0.50 (0.20)*	−0.57 (0.18)**	−0.07 (0.16)
	KT	3.17 (1)			
	PET	3.25 (0.89)			
Special Outcome Expectations (SOE)	PkT	2.07 (0.82)	−0.39 (0.21)	−0.49 (0.18)*	−0.09 (0.17)
	KT	2.47 (1.09)			
	PET	2.56 (0.97)			

*$p \leq 0.05$. **$p \leq 0.005$. ES, Error Standard.

- Regarding the kindergarten sample, significant negative correlations between the teachers' age and SE subscale of the ITIS ($r = -0.40$; $p = 0.004$), SEOE ($r = -0.38$; $p = 0.006$) and SOE ($r = -0.28$; $p = 0.04$) dimensions of the OE subscale of ITIS, were found. Moreover, significant negative correlations between the years of teaching experience and POE ($r = -0.28$; $p = 0.04$) and SEOE ($r = -0.30$; $p = 0.03$) dimensions of the OE subscale of ITIS were found.
- Regarding the primary education sample, a significant negative correlation between the teachers' age and the INT subscale of the ITIS ($r = -0.26$; $p = 0.01$) was found. Moreover, significant negative correlations between the years of teaching experience and SE ($r = -0.210$; $p = 0.04$), INT ($r = -0.26$; $p = 0.01$) subscales of the ITIS, and SEOE ($r = -0.23$; $p = 0.02$) dimension of the OE subscale of ITIS were found.

3.1.4 Regression analysis

According to the results obtained by the correlation analysis and to check for causal relationships between teachers' age and years of teaching experience as predictor variables and subscales of ITIS (SE, OE and INT) as dependent variables, a linear regression analysis was performed.

- Regarding the pre-kindergarten sample, no regression analysis was performed due to the lack of correlation.
- Regarding the kindergarten sample, teachers' age variable was a significant predictor of the SE sub- scale of ITIS ($R^2 = 0.17$, SE = 0.62, $p = 0.004$); SEOE dimension of OE sub-scale of ITIS ($R^2 = 0.15$, SE = 0.77, $p = 0.006$); and, the SOE dimension of OE sub-scale of ITIS ($R^2 = 0.08$, SE = 0.88, $p = 0.05$). Moreover, years of teaching experience variable was a significant predictor of the POE dimension of the OE sub-scale of ITIS ($R^2 = 0.08$, SE = 0.26, $p = 0.04$) and of the SEOE dimension of the OE sub-scale of ITIS ($R^2 = 0.09$, SE = 0.27, $p = 0.03$).
- Regarding the primary education sample, the teachers' age variable was a significant predictor of the INT sub-scale of ITIS ($R^2 = 0.07$, SE = 0.32, $p = 0.01$). Moreover, years of teaching experience variable was a significant predictor of the INT sub-scale of ITIS ($R^2 = 0.07$, SE = 0.12, $p = 0.01$) and the SEOE dimension of OE sub-scale of ITIS ($R^2 = 0.05$, SE = 0.14, $p = 0.02$).

4 Discussion of "School and Educational Technologies" questionnaire results

The current study aimed to explore Italian teachers' beliefs, as measured through specific internal factors—i.e., self-efficacy, outcome expectations, and interest—toward the integration of educational technology in early childhood education. We selected a sample of Italian teachers working with the alpha generation since it roughly encompasses children born in the last ten years who are at the forefront of the digital technology boom and are currently attending pre-kindergarten, kindergarten, and primary education. The results are argued as follows.

4.1 Section A of the "School and Educational Technologies" questionnaire results

Delving into the core of the results obtained from Section A of the "School and Educational Technologies" questionnaire, most of the pre-kindergarten teachers are not aware about educational software or instructional applications that can be used/useful in the classroom, unlike most of both kindergarten and primary education teachers. The apparent lack of awareness of educational software among pre-kindergarten teachers is surprising, given the crucial role such technology plays in modern education. Educational software offers a wide range of benefits, including personalized learning experiences, interactive content delivery, and real-time assessment tools, which can greatly enhance the teaching and learning process (Liu and Yu, 2023; Ng et al., 2023). One potential explanation for this surprising result could be a lack of resources or training opportunities for pre-kindergarten teachers to familiarize themselves with educational software. Indeed, such teachers have only recently and forcibly started dealing with educational technology in response to COVID-19 (Alves et al., 2022; Sutiyono et al., 2022; Ng et al., 2023). As evidence of the latter, most of the pre-kindergarten teachers have never participated in a training course on educational software. On the contrary, most of both the kindergarten and primary education teachers claim to have attended at least one such course. It's noteworthy that the percentage of participation increases with the level of education, which aligns with the observation that higher levels of education correspond to greater familiarity and utilization of educational technologies. All three categories of teachers recognize that they need more training in educational technology. Furthermore, most of the pre-kindergarten, kindergarten and primary education teachers do not have a personal online page or platform to communicate with caregivers and share educational material. This result is also surprising and makes one reflect on the mismatch between the advancement of technological knowledge and the update of Italian teachers. In fact, adopting digital communication would be beneficial for teachers who can communicate with caregivers and share educational material in real time; similarly, it would enable caregivers to stay updated on their children's schooling regardless of their location, serving as a valuable tool for busy caregivers (Kuusimaki et al., 2019; Aviva and Simon, 2021; Levy, 2024).

We also proposed three questions with the aim of finding out what beliefs the teachers in our sample have about the age at which very young children should start using educational technologies in formal educational contexts. Specifically, most of the pre-kindergarten, kindergarten and primary education teachers believe that educational technologies should not be gradually integrated into pre-kindergarten activities. In fact, most of them also believe that children should generally start using technology around age 5, not earlier. In this regard, the age at which children should start using educational technologies can vary depending on several factors, including the type of technology, individual developmental readiness, and educational goals (Gelman and Brenneman, 2004; Burns and Gottschalk, 2020). Although the evidence on the best age to start encountering educational technologies, reference literature (Strouse et al., 2013; Hirsh-Pasek et al., 2015; Hill et al., 2016; Nurdiantami and Agil, 2020) generally suggests that introducing these technologies to children in early childhood, typically around ages 3 to 5, can be beneficial when done in a developmentally appropriate manner and under adult supervision. Thus, our sample of teachers exhibits a strict stance regarding the age at which educational technologies should be introduced in early childhood. In fact, research suggests that controlled use of such technologies can be beneficial for children's development as early as age 3 (Hill et al., 2016; Burns and Gottschalk, 2020).

Finally, although most of the teachers in our sample seem to be skeptical about the adoption of educational technologies with children, all three groups significantly acknowledge the positive role these technologies play for children with special needs, even at preschool age. In this case, the opinion expressed by our sample is completely in line with the evidence in the literature showing that the use of educational technology supports the work of teachers even from early childhood onwards (Cagiltay et al., 2019; Wahome, 2021; Fernandez-Batanero et al., 2022; Lynch et al., 2022). Overall, these

results are interesting as they prompt reflection on how also preconceived ideas, such as the belief that it is not appropriate to use educational technologies before the age of five, can influence one's attitude toward technologies used in early childhood education (Ajzen and Fishbein, 2005; Koc, 2014; Gjelaj et al., 2020).

4.2 Section B of the "School and Educational Technologies" questionnaire results

Regarding the results obtained in Section B of the "School and Educational Technologies" questionnaire, the *post hoc* analysis on the ITIS scale (Niederhauser and Perkmen, 2008; Benigno et al., 2013, 2014) showed that in the self-efficacy subscale of ITIS, the pre-kindergarten teachers perceive themselves as less efficient and competent in using technology in the classroom with children compared to primary education teachers. On the contrary, no difference was found in the perceived efficacy and competence of using educational technologies in the classroom between pre-kindergarten and kindergarten, as well as between kindergarten and primary education teachers. As previously mentioned, it can happen that preconceived ideas about a topic, such as not deeming it appropriate to use educational technology with children in pre-kindergarten, may indirectly influence perceived self-efficacy regarding the ability to utilize technology in education. These preconceived ideas could represent latent and silent variables whose influence should be taken into consideration when aiming to facilitate the smooth integration of educational technology into teaching practices (Yilmaz et al., 2016; Yildirim and Sensoy, 2018). Furthermore, another consideration to be made is that many teachers are aware of the conflicting evidence about the effects of technology use on preschoolers. For example, on the one hand, technology can positively influence children's development by fostering interaction (e.g., Yildirim and Sensoy (2018); Behnamnia et al. (2022); Umarova (2022). On the other hand, its use at home and in the classroom without competent support can negatively influence brain development (Strasburger, 2010; Hill et al., 2016; Yildirim and Sensoy, 2018). Therefore, having a negative perception of one's efficacy in the use of educational technologies may, in turn, indirectly lead to the preconceived idea that technology should not be used with preschoolers. Similarly, the self-efficacy variable may also become a latent variable if not carefully measured (Benigno et al., 2013).

Moreover, the results obtained in both the Performance Outcome Expectations and Social Outcome Expectations dimensions of the outcome expectation subscale of ITIS showed that pre-kindergarten teachers are less convinced that the use of educational technologies in the classroom can make instructional actions more effective, and they are less convinced that using educational technologies in the classroom can increase the positive evaluation of their colleagues, respectively, compared to primary education teachers. No differences for both dimensions were found between pre-kindergarten and kindergarten teachers, as well as between kindergarten and primary education teachers. Similarly, pre-kindergarten teachers believe that using educational technologies in the classroom provides less personal satisfaction (i.e., Self-Evaluative Outcome Expectations dimension of outcome expectation subscale of ITIS) than both kindergarten and primary education teachers. On the contrary, there is no difference in beliefs regarding personal satisfaction when using educational technologies at school between kindergarten and elementary school teachers.

Overall, these results indicate that, especially for pre-kindergarten teachers, the predisposition toward the use of educational technology is influenced both by personal expectation and satisfaction with the results obtained in the classroom and by social desirability phenomenon, i.e., a tendency of individuals to present themselves and their practices in a favorable way (Baker, 1994; Kopcha and Sullivan, 2007; Kopcha, 2012; Wininger et al., 2023).

Not surprisingly, the results obtained in the three dimensions of the outcome expectation subscale of ITIS are in line with those obtained for pre-kindergarten teachers in the self-efficacy subscale of ITIS. Indeed, self-efficacy is closely related to outcome expectations. According to Bandura (1986), while self-efficacy refers to the perceived ability to perform a behavior (Can I do it?), outcome expectation refers to the perceived consequences of performing the behavior (What happens if I try?) (Schwarzer and Luszczynska, 2016; Zeigler-Hill and Shackelford, 2020; Taufiq-Hail et al., 2021). Therefore, if one believes that they do not have the skills to effectively use educational technologies at school, it is quite consequential to believe that the outcome of their educational action mediated by the technologies is not effective. Therefore, they are not satisfied with using them.

Self-efficacy and outcome expectation are two fundamental mechanisms of human behavior; they are crucial for fostering motivation and interest in everyone. This interest appears pivotal in driving goal- oriented behaviors, as individuals tend to engage more in activities where they perceive themselves as competent and anticipate positive outcomes (Reynolds, 2000; Zeigler-Hill and Shackelford, 2020; Sukkamart et al., 2023). Regarding the results obtained in the interest subscale of ITIS, there are no significant differences in the level of interest in using educational technologies in the classroom and in deepening their knowledge related to them among pre-kindergarten, kindergarten, and primary education teachers. This result is noteworthy because all teachers showed an interest in educational technologies and learning about their functionalities.

In summary, the results obtained from Sections A and B reveal a gap between technological advancements and Italian educator's predispositions. Despite their expressed interest in technologies, teachers, particularly those working with preschoolers, express feelings of ineffectiveness and dissatisfaction with them.

4.3 Correlation and regression analyses results

Based on the results obtained from Sections A and B, we aimed to investigate whether these beliefs could be associated with two factors: teachers' age and years of teaching experience. To this end, we conducted a correlation analysis to explore the relationship between these two factors and the subscales of ITIS. Moreover, based on the significant results from the correlation analysis, we conducted a regression analysis to determine whether there is also a causal relationship between these variables. The results confirm that there are causal relationships between the independent variables in our study (i.e., teachers' age and years of teaching experience) and some sub-scales of the ITIS.

Detailed, the results revealed no significant correlation between the subscales of ITIS, teachers' age, and years of teaching experience among pre-kindergarten teachers. For this reason, no further regression analyses were conducted. Thus, for the latter group, the perceived levels of self-efficacy and outcome expectation do not appear to be influenced by age and experience.

On the contrary, based on the significant negative correlations found in kindergarten teachers, the regression analysis results showed that greater teacher age predicts a lower level of perceived self-efficacy (SE subscale of ITIS), lower personal satisfaction with using technology in the classroom (SEOE dimension of the outcome expectation subscale of ITIS), and lower belief that colleagues have a positive impression of using such technologies in the classroom (SOE dimension of the outcome expectation subscale of ITIS). Similarly, greater teaching experience predicts lower personal satisfaction with using technology in the classroom and lower belief that the use of educational technologies makes teaching more effective (POE dimension of the outcome expectation subscale of ITIS).

Likewise, based on the significant negative correlations found among teachers' age, years of teaching experience, and subscales of ITIS for primary education teachers, the regression analysis results showed that greater age and years of experience predict less interest in the knowledge and use of educational technologies (INT subscale of ITIS). Finally, more years of experience predict less personal satisfaction in using such technologies in the classroom (SEOE dimension of the outcome expectation subscale of ITIS).

These results emphasize a trend of negative perceptions toward the use of educational technology, particularly regarding age (where older individuals tend to be less inclined toward technology) and years of teaching experience (where longer tenure correlates with less openness to technological change). These findings align with the broader Italian educational context outlined in the 2018 TALIS report —Teachers and School Leaders as Lifelong Learners (Organisation for Economic Co-operation and Development, 2019) — which indicates that educators in Italy are generally older than average and possess limited familiarity with educational technologies.

4.4 Limitations

Two critical observations on our data appear to be in order. The first pertains to the imbalance in the sample across genders. The sample consisted of 177 women and 3 men. This gender imbalance is not surprising and reflects the gender disparity in favor of women in the educational world (Organisation for Economic Co-operation and Development, 2019). For instance, within the European Union, women significantly outnumber men in the teaching profession: in 2017, from primary to upper secondary education, 75% of teachers were women, compared to 25% men (Organisation for Economic Co-operation and Development, 2019). The situation in Italy mirrors this trend, with an even higher incidence of female teachers. OCSE data from 2019 show that, on average, from pre-school to secondary school, 81.74% of teachers are women (Organisation for Economic Co-operation and Development, 2019). Interestingly, this gender imbalance decreases progressively as the level of education increases. For instance, in kindergarten, 99.7% of teachers are women, while in secondary school, the percentage of women drops to 65.79% (Organisation for Economic Co-operation and Development, 2019). The latter data closely reflects the distribution within our sample. In fact, the teachers in our sample range from pre-kindergarten to primary education: it is in line that 98.3% are women. This gender disparity is related in part to a natural female tendency and greater empathy in working with children (Toussaint and Webb, 2005; Kelley et al., 2023) and in part to biases whereby caring roles, including teaching children, are preferentially for women. These stereotypes may discourage men from considering a career in early childhood education (Rao and Sweetman, 2014; Del Boca et al., 2019; Kelley et al., 2023). Ultimately, it should be considered that the results obtained in our sample are primarily valid for women. In fact, our future goal is to conduct the same study on a selected sample of only male teachers. The second critical observation is related to the unbalanced among pre-kindergarten, kindergarten, and primary education of our total sample of 180 teachers. We acknowledge that the imbalance in our sample is a limit. Nevertheless, we performed the analysis separately on the three groups since the comparison may be intriguing for the purposes of the present study. The future objective will be to increase and balance the sample size.

5 Conclusions and educational implications

In the present study, we answered the research question: What are Italian teachers' beliefs regarding the integration of educational technologies in their daily classroom activities with children attending pre-kindergarten, kindergarten, and primary education? The need to investigate Italian teachers' beliefs arose as a response to the rapid changes in recent years characterized by a digital transformation of the Italian education system, turning how we teach and learn upside down. Consequently, Italian teachers faced a deluge of technology information and passively suffered from it. In this context, examining teachers' beliefs is a crucial first step preceding the success of any intervention to promote seamless technology integration (Brzycki and Dudt, 2005; Buabeng-Andoh, 2012; Di Mascio et al., 2017; Khukalenko et al., 2022; Alenezi et al., 2023; Gkrimpizi et al., 2023; Mhlongo et al., 2023). Specifically, we measured specific internal factors, i.e., self-efficacy, outcome expectations, and interest, using the ITIS scale (Niederhauser and Perkmen, 2008; Benigno et al., 2013, 2014). These internal factors assume unprecedented importance, especially for teachers working with preschoolers, since in Italy, prior to the COVID-19 pandemic, such technologies were sparsely utilized within early childhood educational services (i.e., pre-kindergarten and kindergarten).

In this regard, the results obtained in the present study highlighted that the lower the level of education (i.e., pre-kindergarten), the greater the sense of ineffectiveness, lack of personal satisfaction, and dissatisfaction is with the results manifested by teachers regarding the use of educational technologies. Our results showed that although our teachers have expressed interest in educational technologies, there's a prevailing inclination against their use with preschoolers, coupled with a diminished perception of self-efficacy in using these technologies with preschoolers. These findings are in line with the complex Italian educational landscape, characterized by a teaching staff that is relatively older (with the highest average age in Europe) and possessing low technological skills (among the lowest in Europe)

(Organisation for Economic Co-operation and Development, 2019). We emphasize the need to empower teachers cognitively, socially, interpersonally, and especially technically, as it is unthinkable that new generations would not come into contact with educational technologies, even in formal educational settings, from the earliest years of life. Indeed, the findings of the present study underscore the importance of measuring internal factors and pave the way for promoting the simple integration of educational technologies, suggesting a focus on perceived self-efficacy and outcome expectations exploiting the teachers' interest. To this end, we suggest:

i Provide a method for seamlessly integrating technology into educational practice. Teachers should not only have access to educational technology, but they should also have an effective way to utilize it in their daily teaching activities. An effective way could be the Technological Pedagogical Content Knowledge, which is a cornerstone to facilitate the effective integration of educational technologies into traditional teaching. A teacher who knows what and how to do with technology will have a greater perception of self-efficacy and more confidence in outcome expectations (Mishra and Koehler, 2006; Di Mascio et al., 2018; Caruso et al., 2019, 2023; Peretti et al., 2024).

ii Enriching teachers' knowledge through scientific dissemination seminars, where the beneficial effects that technologies have on children's development are explained if they use it in a controlled manner with restricted access times. Even in this case, the use of an effective method such as the Technological Pedagogical Content Knowledge ensures a regulated use of technology (Jackson et al., 2012; Yildirim and Sensoy, 2018; Nadeem et al., 2023).

iii "Accompanying" the teachers to digital change by making them an active part of it. This means that the teacher is not just required to be given declarative and procedural knowledge (what a particular technology is and how it works). Rather, it means offering the teacher a path of reflection-training on his or her own psychological, behavioral and socio-cultural characteristics to act with a growing capacity for autonomy, judgment, and responsibility. The availability of customized training courses that focus on aspects of self-perception – concerning educational technologies – is, in our opinion, the necessary step to increase the perception and conscious adoption of innovation in this field (Rogers et al., 2003; Benigno et al., 2013, 2014).

The fulfillment of (i), (ii), and (iii), and the subsequent modeling of training paths, can constitute the way to equip the teacher with adequate and positive self-efficacy beliefs that help them resist frustrations, manage stress, and not become discouraged (outcome expectation) during the use of educational technologies in the classroom (Benigno et al., 2014). Overcoming prejudices and distorted cognitions about one's technological efficacy can become a new opportunity for the 21st-century teacher to communicate knowledge that meets the educational needs of digital native students, i.e., alpha generation (Niederhauser and Perkmen, 2008; Benigno et al., 2013; Perry, 2022; Woodcock et al., 2022; Barletta et al., 2023). Indeed, we are amid the Fourth Industrial Revolution, where every aspect of our lives is pervaded by the influence and use of modern information and communication technologies. The educational world cannot be exempt from this digital transformation; it cannot, therefore, be left behind. This is the challenge for future training to ensure the full and conscious use of educational technologies starting from early childhood education.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical approval was not required for the studies involving humans in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

SP: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Writing – original draft, Writing – review & editing. MK: Investigation, Supervision, Writing – original draft, Writing – review & editing. FC: Investigation, Software, Visualization, Writing – original draft. TDM: Funding acquisition, Project administration, Supervision, Writing – review & editing. MG: Data curation, Investigation, Writing – original draft. SD'A: Resources, Supervision, Writing – review & editing. MP: Conceptualization, Data curation, Formal analysis, Methodology, Validation, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Publisher's note

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