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Cognitive and technological recourses in teachers' adaptation to emergency remote teaching

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This study investigates the impact of the abrupt transition to emergency remote learning (ERT), specifically focusing on teachers' cognitive resources and technological resources both before and during ERT. The sample comprised 1,071 teachers: before ERT (53.0%), during ERT (47.0%). Five questionnaires were administered. Results indicated that teachers surveyed during ERT, compared to their counterparts surveyed before ERT, exhibited significantly elevated attitudes toward information and communication technology (ICT), increased usage of the online environment for teaching and use of computers for communication. Additionally, the degree of readiness for educational change significantly contributed to the teachers' changed attitudes toward ICT.

KEYWORDS

emergency remote learning, teachers, ICT, attitudes, educational change

1 Introduction

Effective and adequate teaching in online environments necessitates both technological and cognitive resources. This imperative was accentuated in 2020 when teaching underwent a transformative shift to emergency remote learning (ERT). With more than 80% of educational institutions worldwide closing (Daniel, 2020; Shawaqfeh et al., 2020; UNESCO, 2021), schools and institutes had to adapt by offering their educational programs fully online. The COVID-19 pandemic not only triggered an unprecedented global crisis, impacting physical health and prompting significant societal and personal changes, but it also led to widespread school closures, affecting over 1.2 billion students globally (Cathy and Farah, 2020). The abrupt transition to remote learning, often without adequate training or prior experience, became mandatory for all schools (Wang et al., 2020).

In response to these challenges, it became crucial to explore the technological and cognitive resources employed by teachers in coping with ERT. This study sought to investigate the repercussions of the rapid and unexpected shift to ERT, specifically examining teachers' cognitive resources (attitudes toward ICT and readiness for educational change) and technological resources (usage of the online teaching environment, technology usage for communication, and knowledge) before and during the pandemic.

1.1 Emergency remote teaching

Distance or remote education is a well-known method for teaching and learning that has been studied for decades and has advantages and limitations even with planning by teachers with the profile to do so. Online teaching can enable the flexibility of teaching and learning anywhere, anytime, and a careful consideration of different design decisions will have a

positive impact on the quality of the instruction. However, when forced and with a rushed planning, this careful design process will be absent in most cases in these emergency shifts (Hodges et al., 2020). ERT is a temporary shift of instructional delivery to an alternate delivery mode due to crisis circumstances. It involves the use of fully remote teaching solutions for instruction that would otherwise be delivered face-to-face lessons in the school system, and that will return to that format once the crisis has abated. The primary objective in these circumstances is to provide temporary access to instruction and instructional supports in a manner that is quick to set up and is reliably available during an emergency or crisis (Hodges et al., 2020).

The challenges for teachers, as well as students and their families during a stressful and emergence time such as the pandemic, are wide as lack of motivation, difficulty adapting to remote teaching methods, technical problems, lack of physical spaces to carry out home-based learning etc. On top of that we should consider the impact on mental health and the economic situation (Ferri et al., 2020; Shawaqfeh et al., 2020). As teachers were forced to start teaching remotely within a short time span, even though the digital learning environments and their support systems were not fully ready, it leads to a heavy burden on them (Hadar et al., 2020). Online redesign requires additional time and resources to provide meaningful learning experiences and to create distinctive learning environments with the help of digital technologies (Silva et al., 2022).

Numerous studies have revealed challenges during the school closures for teachers such as lack of resources, including access to educational technologies and the Internet. One problem observed in all countries (albeit to different extents) was insufficient bandwidth, producing delays or connection failures during lessons and video conferences (Ferri et al., 2020). For instance, Thomas and Rogers (2020), have observed that school-provided IT systems are frequently too expensive, cumbersome, and quickly go out of date. Moreover, it is necessary to provide workshops or training for teachers to improve their technological and pedagogical competencies in online teaching.

On top of the technological aspect, we should consider the emergence of new pedagogical aspects. Online learning implies revising the approaches used in face-to-face lessons. Pedagogical patterns must be different in virtual classrooms, and innovations in teaching methods are therefore needed to engage students, stimulating their proactive behavior and to maintain their attention, motivation, and participation on a screen for a long time (Ferri et al., 2020). One of the main limitations in remote teaching is the loss of teacher-student interaction as well as among students (Ferri et al., 2020). Studies shows that the presence of each of the different types of interaction (student-content, student-student, and student-learner), when meaningfully integrated, increases the learning outcomes (Bernard et al., 2009).

Overall, teachers felt overwhelmed and unprepared to use ERT strategies and tools and they struggled to adapt their pedagogy to fluctuating situations (Whalen, 2020). One of the teachers' resources that should help them adjust to the ERT are the technological resources.

1.2 Teachers' technological resources

The compelled shift to remote teaching has propelled teachers to expedite their acquisition of digital technologies (Dikaya et al., 2021). During the pandemic, there was a pervasive and intensive use of

information and communication technology (ICT) for various purposes, as it became the sole means for teachers and students, isolated at home, to maintain communication. Consequently, it is crucial for teachers to adeptly employ ICT, understanding its potential to construct a supportive learning environment that fosters engagement and resilience during stressful ERT situations (Alfredsson Ågren et al., 2020).

Despite the prevailing belief among teachers that they are digitally literate, there is an ongoing importance in learning how to effectively and meaningfully integrate ICT into the classroom, particularly during ERT. Furthermore, teachers' individual experiences with ICT vary, with past encounters influencing their computer efficacy, attitude toward computer use in education, and prospective computer use (Van der Spoel et al., 2020). Mid and late-career teachers, in particular, have historically incorporated technology use into their professional development objectives (Louws et al., 2017). It is imperative to provide training for teachers to enhance digital and specific skills for online education, ensuring they can adeptly plan and implement innovative pedagogical programs (Ferri et al., 2020).

Teachers encountered various technological challenges during the emergency situation, exposing significant gaps in their preparedness and readiness to use technology for remote teaching, as well as in designing and delivering content in remote teaching environments (Whalen, 2020). Notably, disparities in teachers' digital literacy levels and access to technology were evident (Damşa et al., 2021; Meletiou-Mavrotheris et al., 2022; Nicklin et al., 2022). Accessibility barriers were more pronounced for teachers lacking appropriate technological devices, background knowledge, skills, and reliable Internet access at home (Yamamoto and Altun, 2020). Some teachers did not fully grasp the advantages of remote teaching during the pandemic, while others, particularly experienced teachers, gained positive experiences, utilizing various tools and strategies for remote assessment (Meletiou-Mavrotheris et al., 2022; Silva et al., 2022).

Overall, teacher competencies, including technological mastery, exert a significant influence on the success of learning (Albashtawi and Al Bataineh, 2020; Kanya, 2023; Masry-Herzalah and Dor-Haim, 2022). While competencies related to specific online tools can be developed relatively quickly, challenges associated with low psychological and teaching readiness levels are more formidable, often posing serious barriers to achieving high-quality remote learning (Samokhvalova et al., 2020), especially in emergency situations.

1.3 Teachers' cognitive resources

The utilization of technology in teaching is contingent not only upon teachers' technical skills but also on their beliefs, perceptions, and attitudes toward its integration (Heinonen et al., 2019). The significant and abrupt shift during the pandemic has underscored the urgency of investigating teachers' attitudes toward ERT and their perceptions of their activities and performance in online education (Daniel, 2020; Hosseini et al., 2021; Sokal et al., 2020).

Previous research has consistently identified a strong connection between teachers' beliefs and the practical implications of technology-enhanced learning, wherein these beliefs can either facilitate or impede technological educational change. An open and lifelong learning attitude is imperative for teachers to fully engage with ICT-rich education (Blignaut and Els, 2010). Low expectations of the

added value of ICT have been identified as a hindrance to teachers' integration of technology (Amhag et al., 2019; Ottenbreit-Leftwich et al., 2010).

However, the successful adoption of new technology for teaching is challenging and is crucial for the success of both students and educational institutions. Negative attitudes and perceptions toward online learning can pose obstacles (Dhawan, 2020; Hopkins et al., 2020). While attitudes toward ERT have been primarily examined among students, with varied patterns of attitudes and emotions noted (e.g., Aguilera-Hermida, 2020), there is limited exploration of teachers' attitudes, particularly in primary and secondary education. Only few studies explored teachers' attitudes toward ERT, and mostly focus on higher education. For example, Silva et al. (2022) conclude that the less experienced teachers are, the more satisfied they feel with remote classes and remote assessment during the first pandemic period. Another study found a significant change in the perception of primary to higher education teachers regarding their resolutions to implement technology in their lessons in a post-pandemic era.

As teachers play a pivotal role in educational change, particularly in stressful and emergency situations, their ability to adapt to new developments and confront the challenges of change is vital. Readiness for change becomes paramount in this context, involving an individual's emotional, cognitive, and intentional readiness for positive impact (Kirrane et al., 2017). The elaboration concept in the context of readiness for change refers to Bouckenooghe et al. (2009) who explicate the three elements that shape an individual's readiness for change, namely emotional (feelings about the changes), cognitive (thought and belief in the results that can be obtained from these changes) and intentional (efforts and abilities to carry out the process of change). Readiness for change positively influences individual behavior, promoting initiatives, support, prosocial actions, and commitment (Kartika et al., 2021). Researchers stress the importance of readiness for change, as it minimizes the feelings of loss and can reduce resistance to the change (e.g., Fullan, 2016).

Even though readiness for change is important and widely used in different areas, however not so much regarding teachers and education. Readiness to accept changes helps teachers apply 21st-century learning (Ramanan, 2020). Literature reveals that successful quality improvement initiatives in education depend upon the ability of individuals and organizations to adopt new practices (Wanless and Domitrovich, 2015), and the relationship between readiness to change performance and teacher performance was found to be highly correlated (Maksum et al., 2022).

Given the close relationship between technology use in remote teaching, readiness for change, and teacher performance (Ravanelli et al., 2020), it is imperative to investigate these aspects in the context of ERT during the pandemic. Teachers' readiness to adapt to new circumstances during a pandemic significantly influences the teaching and learning process (Andarwulan et al., 2021). The shift to online-based lessons from home presents a formidable challenge, as was previously mentioned, requiring teachers to change established habits and behaviors in the teaching process. The readiness of teachers to alter teaching concepts and methods for online delivery is crucial, impacting lecturer performance during ERT (Kanya, 2023). In conclusion, the need for change in education persists, with the transition to ERT during the pandemic exacerbating this imperative.

1.4 Research objectives and framework

The rapid and involuntary shift to online teaching, prompted by the pandemic, was a highly challenging and overwhelming process, leaving many teachers unprepared due to the brief transitioning period. Coping with this stressful event involves addressing both external and internal challenges (Lifshitz et al., 2022).

While previous studies have explored the utilization of online tools and their contributions to teaching and learning (e.g., Lei and So, 2021; Pozo et al., 2021), and a limited number have investigated teachers' attitudes toward ERT, particularly in higher education (Silva et al., 2022), this research aims to delve into the factors influencing teachers' ERT, encompassing cognitive and technological resources. Specifically, the study seeks to examine three main research questions: (1) Are there differences in teachers' attitudes toward ICT and readiness for educational change (cognitive resources), as well as the usage of the online teaching environment, technology for communication, and knowledge (technological resources), before and during ERT? (2) What is the contribution of teachers' background traits to explaining their attitudes and online usage? (3) Would a unique contribution of online usage be found in explaining teachers' attitudes, beyond the influence of background traits. Figure 1 illustrates the proposed framework for this study.

2 Method

2.1 Participants

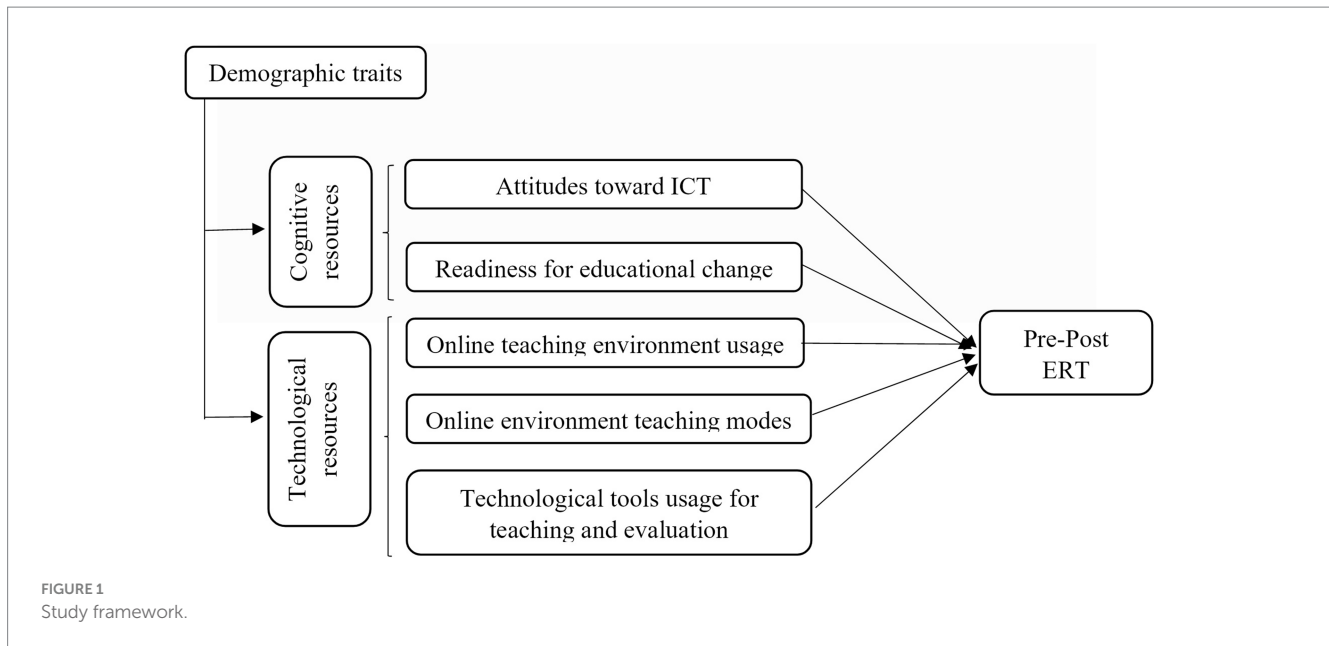
The sample comprised 1,071 teachers (141 males; 930 females). Teachers were sampled at two time points: 53.0% (568 teachers) before the implementation of ERT, and 47.0% (503 teachers) during the use of ERT. The age of the teachers ranged from 22 to 71 years ($M = 39.08$, $SD = 10.46$), and their years of seniority in education ranged from the first year to 45 years ($M = 12.34$, $SD = 10.03$).

To investigate potential significant differences in the distribution of gender, education level, experience in teaching students with special needs, teaching framework, school type, area of expertise and teachers' role within each study group, Chi Square (χ^2) analyses were conducted. Additionally, to explore potential significant differences in the distribution of students' ages and the number of computer-related teacher training courses undergone, Mann-Whitney tests were performed, as these variables are in ordinal scales. The distribution of teachers' background traits by groups (before ERT, during ERT) is presented in Table 1.

As illustrated in Table 1, there were no discernible differences in the distribution of background traits between the two groups of teachers. Additionally, t-test analyses were performed to assess potential disparities in age and years of seniority between the two teacher groups. The results revealed no significant differences in age [$t(1069) = 0.67$, $p = 0.501$] and seniority [$t(1069) = 0.13$, $p = 0.894$] between the two teacher groups.

2.2 Study's tools

- 1 Demographic questionnaire: 14 questions regarding gender, age, years of teaching experience, education level, teaching students with special needs, teaching framework, school type,



students' ages, and the number of computer-related teacher training courses completed.

- 2 Technology frequency use: The questionnaire comprises 5 questions wherein participants assess their usage time on various technological platforms, including SMS/Whatsapp, email, social media, web, Word, and PowerPoint. All items were rated on a 7-point Likert scale, ranging from several time a day (1) to never (7). Additionally, one question about the daily number of computer usage hours employs a 1–4 Likert scale, ranging from not every day (1) to 4+ hours per day (4).
- 3 Teacher attitudes toward ICT (Blau and Antonovsky, 2009): The questionnaire encompasses 15 items rated on a 6-point Likert scale, ranging from completely disagree (1) to completely agree (6). Confirmatory factor analysis with Varimax rotation yielded four indices: (1) Attitudes toward information search by the teacher, exhibiting internal consistency $\alpha=0.90$; (2) Attitudes toward communication via technology, demonstrating internal consistency $\alpha=0.80$; (3) Attitudes toward information search by students, with internal consistency $\alpha=0.77$; and (4) Attitudes toward time investment in online information search by teachers, revealing internal consistency $\alpha=0.74$.
- 4 Usage of online teaching environment (based on the mapping questionnaire, Ministry of Education): Comprising 41 items, the questionnaire utilizes a 4-point Likert scale ranging from not at all skilled (1) to completely skilled (4). The questionnaire is organized into three parts: (1) Assessing familiarity and usage of computer and Internet applications, including organization and treatment, Word processing, presentation, Internet, and pedagogical management tools; (2) Exploring modes of teaching in a technological environment; and (3) Examining the usage of technological tools for teaching and student evaluation. The internal reliability of the questionnaire was found to be high ($\alpha=0.90$).
- 5 Stages of Concern Questionnaire (SoCQ; Hall et al., 1977): The questionnaire was designed to assess teachers' readiness to adapt to changes in the school, focusing on stages of concerns and

needs related to an innovation. Administered exclusively during ERT, it consisted of 15 items selected by Shalit (2001) to gauge individuals' awareness of educational change. These items provided insights into an individual's stage of concern regarding innovation across six categories (awareness, informational, personal, management, consequence, and collaboration) and three clustered areas (self, task, and impact on students). Responses were measured on a 6-point Likert scale, ranging from completely agree (1) to completely disagree (6), where lower scores indicated higher concern levels regarding educational change. The internal consistency was found to be $\alpha=0.713$.

2.3 Procedure

Following ethical approval from the Research Ethics Committee of the University, teachers across Israel were invited to participate in the study through a research invitation containing a link to the online questionnaire. The invitations were distributed at two distinct time points—before the initiation of ERT and during its implementation—via prominent Facebook and WhatsApp groups catering specifically to teachers. The call for participation was exclusively directed at teachers working in mainstream or special education. To increase the sample size, representativeness, and external validity (Baltar and Brunet, 2012), the study also employed the “snowball” sampling technique (Goodman, 1961). Teachers who initially participated were encouraged to invite colleagues from their social or professional networks to join the study. To mitigate potential biases associated with the snowball method and ensure the inclusion of participants from the targeted group, a filtering question was incorporated into the questionnaire. This question required participants to confirm their current role as teachers before or during the ERT period. These measures were designed to enhance the robustness and relevance of the collected data while maintaining a focused and appropriate participant cohort (Baltar and Brunet, 2012).

TABLE 1 Teachers' background traits by time ($N = 1,071$).

Background traits	Values	Time		χ^2	p
		Before ERT ($n = 568$)	During ERT ($n = 503$)		
Gender	Male	78 (13.7%)	63 (13.5%)	0.34	0.560
	Female	490 (86.3%)	440 (87.5%)		
Education	B.A. degree	272 (47.9%)	253 (50.3%)	0.62	0.431
	M.A./PhD degree	296 (52.1%)	250 (49.7%)		
Students with special needs	No	323 (56.9%)	306 (60.8%)	1.73	0.188
	Yes	245 (43.1%)	197 (39.2%)		
Teaching framework	Mainstream	464 (81.7%)	406 (80.7%)	0.17	0.684
	Special education	104 (18.3%)	97 (19.3%)		
School's type	Public school	499 (87.9%)	445 (88.5%)	0.10	0.755
	Religious school	69 (12.1%)	58 (11.5%)		
Students' age ¹	Kindergarten	8 (1.4%)	27 (5.4%)	134997.50	0.085
	Elementary	304 (53.5%)	281 (55.9%)		
	Middle-school	129 (22.7%)	66 (13.1%)		
	High-school	127 (22.4%)	129 (25.6%)		
Number of computer-related teacher training courses ¹	0	143 (25.2%)	105 (20.9%)	138146.00	0.325
	1–2	236 (41.5%)	230 (45.7%)		
	3–4	117 (20.6%)	99 (19.7%)		
	5 or more	72 (12.7%)	69 (13.7%)		
Area of expertise	Humanities	405 (71.3%)	367 (73.0%)	0.36	0.546
	Sciences	163 (28.7%)	136 (27.0%)		
Teacher's role	Educator	270 (47.5%)	252 (50.1%)	0.70	0.402
	Specialist teacher	298 (52.5%)	251 (49.9%)		

¹Variable in an ordinal scale – Mann–Whitney analysis was conducted.

Additionally, participants were explicitly informed that their participation was entirely voluntary, and assurances were given that their responses would be treated anonymously. It is noteworthy that only fully completed questionnaires, constituting approximately 80% of the submissions, were included in the analysis.

3 Results

3.1 Teachers' attitudes toward ICT, computers and online environment usage by time

To explore disparities in the attitudes toward ICT, the usage of the online environment for teaching, and the frequency of using computers for communication between teachers sampled before the initiation of ERT and those sampled during its implementation, a one-way Multivariate Analysis of Variance (MANOVA) was performed (refer to Table 2).

As depicted in Table 2, teachers sampled during the ERT exhibited significantly higher scores on the questionnaire assessing teachers' attitudes toward ICT. They also demonstrated greater utilization of the online environment for teaching and a higher frequency of using computers for communication, in comparison to teachers sampled before the initiation of ERT [$F(1,1,069) = 9.97, p = 0.002, \eta_p^2 = 0.01, F$

(1,1,069) = 5.09, $p = 0.024, \eta_p^2 = 0.01$ and $F(1,1,069) = 14.51, p < 0.001, \eta_p^2 = 0.01$, respectively].

For a more in-depth examination of the variations in teachers' attitudes toward ICT over time, an additional one-way MANOVA analysis was conducted, focusing on the four factors of the questionnaire. The outcomes revealed that teachers sampled during the ERT scored significantly higher on three factors: teacher online information search, online communication, and investment in teacher online information search [$F(1,1,069) = 8.34, p = 0.004, \eta_p^2 = 0.01, F(1,1,069) = 5.07, p = 0.025, \eta_p^2 = 0.01$ and $F(1,1,069) = 25.99, p < 0.001, \eta_p^2 = 0.02$, respectively]. Conversely, no significant difference was observed in the factor related to student online information search, $F(1,1,069) = 0.01, p = 0.904, \eta_p^2 = 0.00$ (see Table 2).

For a more comprehensive analysis of the distinctions in the extent of teachers' utilization of the online environment for teaching, an additional one-way MANOVA analysis was conducted, examining the three factors of the questionnaire over time. The results revealed that teachers sampled during ERT scored significantly higher on two factors: online environment teaching modes and technological tools' usage for teaching and evaluation, in comparison to teachers sampled before the initiation of ERT [$F(1,1,069) = 27.44, p < 0.001, \eta_p^2 = 0.03$ and $F(1,1,069) = 9.02, p = 0.003, \eta_p^2 = 0.01$, respectively]. Conversely, no significant difference was identified in the factors related to familiarity and usage of computer/Internet applications, $F(1,1,069) = 0.50, p = 0.478, \eta_p^2 = 0.00$ (refer to Table 2).

TABLE 2 Mean and SD of the teachers' attitudes toward ICT, computers and online environment usage by time ($N = 1,071$).

Dependent variables	Time				F	p	η_p^2
	Before ERT ($n = 568$)		During ERT ($n = 503$)				
	M	SD	M	SD			
Teachers' attitudes toward ICT							
Attitudes toward ICT-total	4.56	0.87	4.71	0.68	9.97**	0.002	0.009
Teacher online information search	5.23	0.99	5.38	0.71	8.34**	0.004	0.008
Online communication	4.56	1.07	4.70	0.91	5.07*	0.025	0.005
Student online information search	4.16	1.11	4.17	1.02	0.01	0.904	0.000
Teacher online information search investment	3.82	1.40	4.22	1.16	25.99***	0.001	0.024
Online teaching environment usage							
Online teaching environment usage-total	2.97	0.58	3.05	0.58	5.09*	0.024	0.005
Familiarity and usage of computer/Internet	3.38	0.56	3.40	0.54	0.50	0.478	0.000
Organization and treatment	3.77	0.50	3.75	0.46	0.16	0.692	0.000
Word processing	3.55	0.65	3.55	0.61	0.00	0.999	0.000
Presentation	3.06	0.84	2.98	0.84	2.58	0.109	0.002
Internet	3.46	0.60	3.59	0.50	13.81***	0.001	0.013
Pedagogical management tools	3.00	0.89	3.10	0.88	3.24	0.072	0.003
Online environment teaching modes	2.59	0.80	2.83	0.71	27.44***	0.001	0.025
Technological tools usage for teaching and evaluation	2.24	0.92	2.41	0.91	9.02**	0.003	0.008
Computers for communication usage frequency							
Frequency of using computers for communication-total	5.99	0.75	6.17	0.72	14.51***	0.001	0.013

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Furthermore, the teachers were asked to specify their familiarity and usage level of computer/Internet applications across five different types: organization and treatments, Word processing, presentation, Internet, and pedagogical management tools. To assess variations in these five types over time, a one-way MANOVA analysis was conducted. The results revealed that teachers sampled during ERT scored significantly higher only in the usage of the Internet for teaching, $F(1,1,069) = 13.81$, $p < 0.001$, $\eta_p^2 = 0.01$. Conversely, no significant differences were observed in the level of familiarity and usage of organization and treatment applications, Word processing, presentation, and pedagogical management tools over time [$F(1,1,069) = 0.16$, $p = 0.692$, $\eta_p^2 = 0.00$, $F(1,1,069) = 0.00$, $p = 0.999$, $\eta_p^2 = 0.00$, $F(1,1,069) = 2.58$, $p = 0.109$, $\eta_p^2 = 0.00$ and $F(1,1,069) = 3.24$, $p = 0.072$, $\eta_p^2 = 0.00$, respectively] (refer to Table 2).

3.2 The contribution of background traits to the EPV of teachers' attitudes and online usage

To assess whether teachers' background traits significantly contributed to the explained variance (EPV) in their attitudes toward ICT, usage of the online environment for teaching, and the frequency of using computers for communication, three stepwise multiple regression analyses were conducted. Only variables with a noteworthy contribution to the EPV were included in the regression model, ordered by significance. Furthermore, the variable introduced in each subsequent step contributed significantly to the EPV beyond the

variable entered in the previous step. This stepwise approach aimed to reduce the likelihood of multicollinearity (refer to Table 3).

The outcomes of the regression analyses revealed that teachers' background traits significantly contribute to the EPV of their attitudes toward ICT, usage of the online environment for teaching, and the frequency of using computers for communication [4.3, 14.1, and 10.3%, respectively].

Concerning teachers' attitudes toward ICT, positive β coefficients were observed for the variables of time, computer-related teaching training courses, and students' age. This indicates that teachers sampled during the ERT, those who underwent a greater number of computer-related teaching training courses, and those teaching older students scored significantly higher on the teachers' attitudes toward ICT questionnaire. Conversely, negative β coefficients for the variables of seniority years, type of school, and teaching framework suggested that teachers with fewer teaching years, those teaching in public and mainstream schools, scored significantly higher on the teachers' attitudes toward ICT questionnaire.

Regarding the usage of the online environment for teaching and learning, positive β coefficients were found for the variables of computer-related teacher training courses, students' age, and time. This implies that teachers sampled during ERT, those who underwent more computer-related teaching training courses, and those teaching older students scored significantly higher on the usage of the online environment for teaching. Conversely, negative β coefficients for the variable of seniority years indicated that teachers with fewer teaching years scored significantly higher on the usage of the online environment for teaching.

TABLE 3 Multiple and hierarchical regression analyses results for the teacher attitudes, online environment usage by background traits ($N = 1,071$).

Variables explained	Steps	Variables which contribute to the EPV	B	SE.B	β	R^2	ΔR^2
Multiple regression analyses							
Teachers' attitudes toward ICT		Time ¹	0.15	0.05	0.10***	0.009**	0.009**
		Computer-related training courses	0.11	0.03	0.13***	0.017***	0.007**
		Seniority years	-0.01	0.00	-0.11***	0.027***	0.010**
		Students' age	0.07	0.03	0.08**	0.033***	0.006**
		Type of school ²	-0.20	0.07	-0.08**	0.038***	0.005*
		Teaching framework ³	0.15	0.06	-0.07*	0.043***	0.005*
Online teaching environment usage		Computer-related training courses	0.22	0.02	0.35***	0.053***	0.053***
		Seniority years	-0.02	0.00	-0.30***	0.125***	0.072***
		Students' age	0.07	0.02	0.11***	0.137***	0.012***
		Time ¹	0.07	0.03	0.06*	0.141***	0.004*
Computer for communication usage		Seniority years	-0.02	0.00	-0.31***	0.049***	0.049***
		Computer-related training courses	0.10	0.02	0.13***	0.065***	0.016***
		Type of school ²	-0.24	0.07	-0.11***	0.078***	0.013***
		Time ¹	0.17	0.04	0.11***	0.090***	0.013***
		Education ⁴	0.14	0.05	0.10**	0.009***	0.008**
		Gender ⁵	0.15	0.06	0.07*	0.103***	0.005*
Hierarchical regression analyses							
Teachers' attitudes toward ICT (controlling background traits)	1	Time ¹	0.08	0.04	0.05*	0.009**	0.009**
		Computer-related training courses	-0.03	0.03	-0.04	0.017***	0.007**
		Seniority years	0.00	0.00	0.05	0.027***	0.010**
		Students' age	0.02	0.02	0.02	0.033***	0.006**
		Type of school ²	-0.10	0.07	-0.04	0.038***	0.005*
		Teaching framework ³	-0.08	0.05	-0.04	0.043***	0.005*
	2	Online teaching environment usage	0.58	0.04	0.43***	0.249***	0.206***
		Computer for communication usage	0.14	0.03	0.14***	0.263***	0.014***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; ¹ Time - 0: Before ERT, 1: During ERT; ² Type of school - 0: Public school, 1: Religious school; ³ Teaching framework - 0: Mainstream schools, 1: Special education schools; ⁴ Education - 0: B.A. degree, 1: M.A./PhD. degree; ⁵ Gender - 0: Males, 1: Females.

Regarding the teachers' frequency of using computers for communication, positive β coefficients were found for the variables of computer-related teacher training courses, time, teachers' educational level, and gender. This suggests that teachers sampled during ERT, those who underwent a higher number of computer-related teaching training courses and had a higher educational level, also exhibited a higher frequency of using computers for communication. Conversely, negative β coefficients for the variables of seniority years and type of school indicated that teachers who teach in public schools and had fewer seniority years in teaching exhibited a higher frequency of using computers for communication.

3.3 The contribution of online usage to the EPV of the teachers' attitudes, beyond the teachers' background traits

To assess whether the usage of the online environment for teaching and the frequency of using computers for communication significantly contributed to the EPV of teachers' attitudes toward ICT,

beyond the six background traits included in the regression model, a hierarchical regression analysis was conducted. The teacher's background traits were introduced in the first step of the regression, followed by the stepwise addition of the teacher's usage of the online environment for teaching and the teacher's usage of computers for communication in the second step.

The findings revealed that the teachers' usage of the online environment for teaching contributed significantly by 20.6%, and the frequency of computer communication usage contributed an additional 1.4% to the EPV of teachers' attitudes toward ICT, beyond the teacher's background traits. The positive β coefficients suggested that the more teachers used the online environment and computers for communication, the higher their attitudes toward ICT.

The contribution of background traits, readiness for change and online usage to the EPV of teachers' attitudes.

To assess whether teachers' background traits, readiness for educational change, and usage of the online environment and computers for communication significantly contributed to the EPV of

TABLE 4 Regression analysis for the teacher attitudes, by background traits, readiness for change, online teaching environment and computers usage during ERT (N = 503).

Variables explained	Steps	Variables which contribute to the EPV	B	SE.B	β	R ²	ΔR^2
Teachers' attitudes toward ICT (controlling background traits)	1	Computer-related teacher training courses	0.12	0.03	0.16***	0.026***	0.026***
	2	Computer-related teacher training courses	0.09	0.03	0.13**		
		The degree of readiness for educational change	0.19	0.04	0.23***	0.077***	0.050***
	3	Computer-related teacher training courses	0.02	0.03	0.03		
		Readiness for educational change	0.05	0.04	0.06		
		Online environment for teaching usage	0.52	0.05	0.44***	0.230***	0.153***

** $p < 0.01$; *** $p < 0.001$.

teachers' attitudes toward ICT during ERT, a hierarchical regression analysis was conducted. The teacher's background traits were included in the first step of the regression. Subsequently, in the second step, the degree of readiness for educational change among teachers was introduced in a stepwise manner. In the third step, the teachers' usage of the online environment for teaching and the frequency of using computers for communication were added in a stepwise manner. This analysis was performed exclusively for the teachers who were sampled during ERT, as the readiness for educational change questionnaire was administered only to this group (refer to Table 4).

The outcomes of the regression analysis revealed that the number of computer-related teacher training courses undertaken by teachers significantly contributed by 2.6% to the EPV of teachers' attitudes toward ICT during ERT. The positive β coefficient signified that teachers who completed a greater number of computer-related training courses scored significantly higher on the teachers' attitudes toward ICT questionnaire.

Furthermore, the degree of readiness for educational change introduced an additional 5.0% to the EPV of teachers' attitudes toward ICT beyond the influence of the number of courses. The positive β coefficient indicated that a higher degree of readiness for educational change among teachers was associated with higher attitudes toward ICT.

Lastly, the teachers' usage of the online environment for teaching contributed significantly by 15.3% to the EPV of teachers' attitudes toward ICT, extending beyond the effects of the preceding variables in the regression model. The positive β coefficients suggested that a higher level of online environment usage by teachers correlated with higher attitudes toward ICT.

4 Discussion

One of the primary challenges faced by teachers during the stressful and emergent period of the pandemic was the abrupt transition to ERT, for which they were unprepared (Chen, 2021; Estrella, 2022). This study aimed to explore the factors influencing school teachers' ERT, considering both cognitive and technological resources—a combination of variables that is still underrepresented in the existing literature.

Upon examining cognitive resources before and during the implementation of ERT, it was observed that teachers exhibited elevated attitudes toward ICT, specifically in areas such as teacher online information search, online communication, and teacher

online information search investment, during the use of ERT when compared to teachers sampled before ERT. Notably, no discernible difference was identified in the factor related to student online information search, as this pertains solely to the students themselves.

Prior research has primarily delved into this matter within the student population, revealing varied attitudes—both positive and negative (e.g., Aguilera-Hermida, 2020; Dikaya et al., 2021; Palacios et al., 2020). Limited studies have explored teachers' attitudes toward ERT, with a predominant focus on higher education. These studies uncovered that less experienced teachers express greater satisfaction with ERT and a willingness to integrate technology into their teaching practices (Silva et al., 2022; Van der Spoel et al., 2020). Comparable findings extend to other technologies; for instance, a positive correlation exists between teachers' attitudes toward iPad use and their actual iPad usage (Eden et al., 2019). Another study focused on pre-service teachers and found that participants' positive perceptions of virtual reality in teaching related to their use of it and its potential to engage learners (Cooper et al., 2019). Thus, it appears that as teachers actively engage in ERT and gain firsthand experience, their attitudes toward ICT tend to improve. We recommend further investigation into this aspect, urging a reevaluation of teachers' attitudes in the post-ERT era.

Teachers' attitudes are pivotal in educational change, especially during ERT (Sokal et al., 2020). The shift to online teaching during the COVID-19 pandemic elicited diverse cognitive responses from teachers. While some viewed it as a pragmatic solution to ensure both continuity of learning and safety, others perceived online instruction as an undue burden on both teachers and parents (Newcamp, 2020). In this context, we explored teachers' readiness for educational change, recognizing its role in minimizing feelings of loss and reducing resistance to change (e.g., Fullan, 2016). This readiness becomes particularly crucial in the teaching process, especially amid the pandemic, which demanded a shift in teachers' habits and behavior (Andarwulan et al., 2021). Our study specifically investigated this factor during ERT, revealing its significant contribution to the EPV of teachers' attitude changes toward ICT. In essence, a higher degree of readiness for educational change corresponded to elevated attitudes toward ICT. Consequently, we can infer that teachers' ability to embrace new practices during ERT is contingent upon their readiness for change. As emphasized by Wanless and Domitrovich (2015), successful quality improvement initiatives in education hinge on individuals' and organizations' capacity to adopt new practices. The correlation between readiness for change and teacher performance has

also been strongly evident in previous research (Kanya, 2023; Maksum et al., 2022; Ravanelli et al., 2020).

In the realm of technological resources, prior research has underscored that the abrupt shift to remote teaching has compelled teachers to hasten their proficiency in digital technologies (Dikaya et al., 2021). However, our current study delves into a broad spectrum of technologies employed by teachers both before and during ERT. It reveals heightened usage of the online environment for teaching, encompassing online environment teaching modes and the utilization of technological tools for teaching and evaluation, during ERT. Notably, there were no disparities in the familiarity and usage of computer/Internet applications, except for the use of the Internet for teaching. Additionally, a more frequent use of computers for communication emerged during ERT compared to the period before its implementation. This heightened reliance on Internet-based applications, such as Zoom or similar tools, was a necessity for conducting lessons in the ERT setting. Consequently, the observed change appears to be specifically linked to aspects directly associated with online teaching, rather than the utilization of pedagogical or management tools.

Our investigation underscores the critical importance of teachers effectively utilizing ICT to support their learning environment, even when they perceive themselves as digitally literate (Alfredsson Ågren et al., 2020; Ferri et al., 2020). Amidst the technological challenges confronted during ERT, which included shortcomings in preparation and readiness to employ technology, design and deliver content in remote teaching environments, and deficiencies in technological background knowledge and skills (Meletiou-Mavrotheris et al., 2022; Nicklin et al., 2022; Whalen, 2020; Yamamoto and Altun, 2020), teachers had to grapple with these difficulties. In essence, it can be inferred that teachers' overall technological competencies wield significant influence over the success of remote teaching, particularly in emergency situations (Kanya, 2023; Masry-Herzalah and Dor-Haim, 2022).

It is pertinent to note that teachers' ICT experiences exhibit a connection with their attitudes toward ICT, a finding consistent with Van der Spoel et al. (2020). Furthermore, perceptions of the online environment may encompass a combination of attitudes and experience, influenced by various of individual characteristics as well as contextual and cultural factors (Hung et al., 2010). An examination of teachers' background traits revealed their significant but comparatively modest contribution to the EPV of teachers' attitudes toward ICT, the usage of the online environment for teaching and learning, and the frequency of using computers for communication. This contribution was overshadowed by the more substantial impact of teachers' utilization of the online environment for teaching and the frequency of using computers for communication.

5 Study limitations and conclusions

The study aims to explore teachers' cognitive resources—namely, their attitudes toward ICT and readiness for educational change—as well as their technological resources, including the use of online teaching environments, communication technologies, and knowledge, both before and during ERT. A total of 1,071 teachers completed five questionnaires, and the results revealed that those measured during ERT demonstrated significantly more positive attitudes toward ICT,

along with greater usage of online teaching environments and computers for communication, compared to those surveyed before ERT. Furthermore, teachers' readiness for educational change was a significant predictor of their improved attitudes toward ICT.

Although this study significantly advances our comprehension of the impact of the unforeseen transition to ERT on teachers' cognitive and technological resources, it is imperative to acknowledge certain limitations. The utilization of self-report questionnaires introduces the potential for social desirability bias. To address this concern, we implemented measures to ensure the confidentiality and anonymity of participants, fostering an environment conducive to truthful responses. Additionally, the examination of teachers' readiness for change occurred only once, during ERT.

Given the distinct challenges posed by the COVID-19 threat to educational institutions, the potential need for ERT should be incorporated into teachers' skill sets. Adequate preparation for future ERT requirements is crucial. Online tools will persist in playing a pivotal role in delivering flexible, adaptive, and effective education, particularly within blended learning models (Ratten, 2023). These tools will also be essential in responding to future ERT crises, such as wars (e.g., the ongoing conflicts in Ukraine or Israel) or other pandemics, where rapid shifts to remote learning may again be required.

While this study delves into some of the key cognitive and technological resources influencing teachers' experiences with ERT, further research is essential to provide comprehensive support, preparation, and professional development. One important direction for future research is to investigate the long-term effects of ERT on teachers' professional practices and attitudes toward ICT. Studies could assess how skills acquired during ERT are retained and adapted in post-pandemic, blended, or hybrid teaching environments. Additionally, there is a need to examine the specific challenges faced by teachers in different educational contexts, such as special education or rural areas, where access to technology and support may vary. Future research could also focus on identifying the most effective professional development strategies that enable teachers to seamlessly transition between in-person and remote teaching formats. Exploring how educational institutions can develop infrastructure and policies that better support teachers during emergencies is another critical area of inquiry.

By addressing these areas, future studies can help ensure that teachers are better equipped to handle the complexities of ERT, while also enhancing their ability to integrate technology into everyday teaching practices in a more meaningful and sustainable way.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The data will be available upon reasonable request. Requests to access these datasets should be directed to Sigal Eden, sigal.eden@biu.ac.il.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the

participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

SE: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Data curation, Conceptualization.

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Conflict of interest

The author declares 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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