education sciences

MDPI

Article

Teachers' Self-Efficacy during the COVID-19 Pandemic in Greece: The Role of Risk Perception and Teachers' Relationship with Technology

Eleni Andreou [1,*], Christina Roussi [2], Stella Tsermentseli [1], Laura Menabò [3] and Annalisa Guarini [3]

[1] Department of Primary Education, University of Thessaly, 38221 Volos, Greece
[2] Department of Special Education, University of Thessaly, 38221 Volos, Greece
[3] Department of Psychology, University of Bologna, 40146 Bologna, Italy
* Correspondence: elandr@uth.gr

Abstract: The COVID-19 pandemic has led to a sudden and radical transition from face-to-face to online teaching across the globe. This shift has required teachers to quickly adapt their educational practices, which has had an impact on their perceived self-efficacy. The limited literature on the impact of COVID-19 on teachers' self-efficacy (TSE) has focused mostly on online teaching. The purpose of this study was to investigate TSE in both face-to-face and distant learning environments amid the COVID-19 pandemic. It also aimed to explore the impact of teachers' relationship with technology and COVID-19 risk perception on their TSE. The sample was composed of 290 pre-service and in-service teachers from Greece who completed an online self-report survey. Results showed that pre-service teachers reported higher levels of TSE than in-service teachers, especially in distance learning environments. COVID-19 risk perception was not a significant predictor of TSE. By contrast, higher scores in self-assessed skills of the pedagogical applications of technology predicted TSE in both instructional settings. The present findings confirm the importance of promoting technological skills to enhance the self-efficacy of schoolteachers in both traditional and virtual instructional settings, regardless of the crisis due to the COVID-19 pandemic.

Keywords: self-efficacy; COVID-19; risk perception; educational technology; distance learning

Citation: Andreou, E.; Roussi, C.; Tsermentseli, S.; Menabò, L.; Guarini, A. Teachers' Self-Efficacy during the COVID-19 Pandemic in Greece: The Role of Risk Perception and Teachers' Relationship with Technology. *Educ. Sci.* **2022**, *12*, 600. https://doi.org/10.3390/educsci12090600

Academic Editor: Eila Jeronen

Received: 19 August 2022
Accepted: 30 August 2022
Published: 2 September 2022

1. Introduction

The outbreak of the 2019 novel coronavirus disease (COVID-19) and its identification as a pandemic urged governments in many countries to announce measures, including lockdowns, to limit COVID-19 spreading. Demanding changes were caused in daily life, affecting public health, economy, occupational fields, and education. School closures, decided by governments, posed challenges to teachers, students and parents and forced schools to a rapid transition to alternative means of schooling, specifically distance learning, to achieve instructional goals and contact with students [1–3]. This sudden shift has added to the already demanding workload of teachers and has been a source of additional stress and anxiety, which in turn has influenced their self-efficacy [4].

Teacher self-efficacy (TSE) refers to teachers' judgment of their capabilities to bring about desired outcomes of student engagement and learning to all students [5,6]. TSE is strongly related to several positive outcomes for both teachers and students. As for teachers, commitment, persistence and instructional behavior correlate with self-efficacy, and as regards students, TSE is powerfully related to achievement, motivation and self-efficacy beliefs [7]. Pressley [4] highlighted the challenges raised by distance learning due to COVID-19 and explored how the new teaching approaches and requirements because of COVID-19 impacted elementary teachers' instructional and engagement self-efficacy. Teaching virtually was related to lower instructional efficacy scores than teachers teaching in a hybrid or all in-person model, but no difference in engagement efficacy scores was

found based on the instructional approach [4]. These findings have shed some light on the impact of COVID-19 on teachers' self-efficacy and highlighted the importance of further exploration of the factors influencing self-efficacy beliefs during the COVID-19 pandemic.

According to Bandura's social cognitive theory [6], the first and the most powerful source of self-efficacy is mastery experience. Mastery experience is conceptualized as one's interpretations of his/her own previous, authentic experiences performing a particular task. The theory proposes that a successful mastery experience improves one's efficacy, while an unsuccessful mastery experience weakens it. Indeed, it has been found that advanced teacher training and the perception of the ease of ICT use were related to greater confidence in distance teaching [8] and that better coping with technology seems to support TSE [9]. In the COVID-19 context, it has been shown that teachers who have had previous experience in online teaching scored higher on their TSE during the emergency transition from in-person to virtual learning environments [10,11]. Further exploration of more specific aspects of teachers' use of technology and their correlates with TSE for face-to-face and distance teaching during COVID-19 pandemic is warranted.

Based on Bandura's model, the perception of emotional and physiological states are also assumed to partially inform self-efficacy beliefs [6]. In general, positive emotions make individuals feel more competent; on the other hand, negative perceptions can lower self-efficacy expectations. During COVID-19, instability in daily life is accompanied by a constant risk of contamination and death [12]. Therefore, teachers' perception of disease risk could be among the factors that may influence their self-efficacy. Indeed, recent studies have shown that a higher general risk perception and fear of COVID lowers self-efficacy [13,14]. Nabe-Nielsen and her colleagues [12] also examined teachers' risk management and emotional reactions to the COVID-19 pandemic. They indicated that risk perception was higher in teachers exposed to infected students or colleagues [12]. According to the authors' knowledge, no research relevant to the above mentioned research has been conducted in Greece, and overall no studies have investigated the role of teachers' specific COVID-19-related risk perception on their perceived self-efficacy in relation to face-to-face and distance education One could argue that distance teaching eliminates exposure to the virus and the possibility of transmitting the infection, leading to lower risk perception among teachers.

Present Study

The current study addresses the gaps mentioned above by examining TSE in both face-to-face and distant learning environments during COVID-19 pandemic, and by exploring the impact of multiple domains of teacher's use of technology and COVID-19 risk perception on their TSE. As this research is among the first attempts to study those experiences of Greek teachers, to focus on gender differences and teaching status seems a plausible starting point. To this end, the first aim of the study was to explore in-service and pre-service teachers' self-efficacy scores in instruction and engagement during the 2020–2021 school year at the different instructional levels (i.e., face-to-face and distance learning). To our knowledge, TSE at both instructional levels amid the COVID-19 pandemic has only been investigated in a USA sample [4]. We were interested to investigate self-efficacy in Greece, thus extending this line of research in a different cultural and educational setting. We also wanted to investigate whether specific teacher characteristics (i.e., gender) or situational conditions, (i.e., whether in an in-service condition or not) were related to self-efficacy scores. Previous studies have found that TSE increases with teachers' experience [15] and reported that female teachers have higher self-efficacy in instructional strategies and student engagement [16]. The present study sought to examine whether a similar pattern would be found in the context of the COVID-19 pandemic.

The second and primary aim of the study was to explore specific correlates of teachers perceived self-efficacy during COVID-19 crisis. Most studies investigating correlates of teacher self-efficacy during the pandemic, concentrated upon the effect of self-efficacy on teachers' coping with stressful situations, e.g., [3]. The novelty of the present study

lies in the study of teachers' risk perception about COVID-19 as a potential predictor of teacher self-efficacy. It is also the first study to investigate whether multiple aspects of teachers' relationship with technology (e.g., perceived usefulness of technology, ease of use, efficiency to apply pedagogical skills via technology) would contribute to the perceived self-efficacy (in both person and in distance teaching) within the context of COVID-19 risk perception. According to Bandura's self-efficacy theory [6], the most powerful source of self-efficacy is mastery experience, we therefore, expected that a positive relationship with technology would be the stronger predictor of teacher's self-efficacy above and beyond potential co-variates and COVID-19 risk perception. Findings from the present study will help to advance our understanding of how teachers' relationships with technology may influence their self-efficacy, in the hope of better understanding teachers' support and training needs upon transition to online learning environment during the current pandemic crisis, a potential future emergency and beyond.

Therefore, to achieve the aims of the present study, the following research questions (RQ) were formed:

QR1. Do teacher characteristics (i.e., gender and teacher status) relate to TSE, COVID-19 risk perception and relationship with technology amid the COVID-19 pandemic?
QR2. Does teachers' COVID-19 risk perception predict their TSE in person and in distance teaching?
QR3. Does teachers' positive relationship with technology contribute to TSE (in person and in distance teaching) within the context of COVID-19 risk perception?

2. Method

2.1. Participants and Procedure

A total of 290 teachers (78.7% women and 21.3% men) from central Greece participated in an online research survey. Of these, 189 (65.2%) were working as teachers employed primarily on public schools, and 101 (34.8%) were non-appointed teachers or were self-employed in private tuition (i.e., pre-service teachers). Concerning their age group variation, 20.7% were self-identified to the group between 21 and 30 years of age, 33.5% 31–40 years of age, 26.2% 41–50 years of age, 18.3% 51–60 years of age and 1.2% were over 61 years of age.

From the group of in-service teachers, 32 (17.2%) were in kindergarten settings, 80 (43%) were in primary schools, 37 (19.9%) in lower secondary schools and 37 (19.9%) in upper secondary schools. From the pre-service teachers' group, 23 (22.8%) were specialized as kindergarten teachers, 38 (37.7%) as primary, and 40 (39.6%) were specialized to work in secondary (lower and upper) education. At the time of the questionnaire completion, 72.5% of the pre-service teachers and 65.2% of the in-service teachers reported being in a lockdown condition due to COVID-19 restrictions.

Data were collected online between September 2020 and February 2021, with the questionnaire taking about 20 min to complete. The questionnaire was administered via online Qualtrics survey platform and was accessed by participants using a designated link, which was disseminated through the researchers' and teachers' social networks and e-mail listservs resulting in the snowball sampling technique. It was emphasized in the electronic form that there was no correct answer to the questions, the identity of the participants would be kept confidential and their answers would only be used for scientific purposes. The responsible Ethics Committee approved the study.

2.2. Measures

A multi-item survey with an online questionnaire was set out to evaluate many aspects of teachers' experience with in-person and distance teaching during the COVID-19 pandemic. Demographic information such as gender, teaching status (in-service appointment and non-in-service), categorical age groups and questions regarding being in a lockdown situation led the main questionnaire, which included items focused on the risk perceptions about COVID-19, perceived teachers' self-efficacy in in-person and distance teaching and

multiple aspects of their relationship with technology. The scales included in our study can be originally found in the studies of Gerhold's [17], Tschannen-Moran [7], and Teo [18,19]. The items of the final questionnaire were translated from English into Greek by a competent speaker of both languages and then discussed with teachers for the understanding and clarity of the content.

Risk Perceptions about COVID-19: To measure teachers' risk perception about COVID-19, we used the basis of a COVID -19 subscale from Gerhold's study [17]. A total of 3 subscales were employed and in the cases of multi-item subscales, *Cronbach's alpha* was calculated to test the hypothesis of their internal consistency to be calculated as a single score. The first subscale was the risk of contamination. Originally, in Gerhold's study [17], it consists of three items, while in the present study, the item "*How likely do you think it is that people in your family and friends might become infected with COVID-19 (Coronavirus SARS-CoV-2) in the near future?*" was split into 2 items, separately for family and friends resulting in 4 final items (*Cronbach's alpha 0.90*) The second subscale analyzed the risk in school environment (1 item) "*How likely do you think it is that you might become infected with COVID-19 (Coronavirus SARS-CoV-2) in the school environment?*". The last subscale investigated the risk of death concerning self, family and friends, added in the present study, by altering the verb "*become infected*" with "*would die*" of the original Gerhold's [17] subscale (3 items, *Cronbach's alpha* = 0.87 (e.g., "*How likely do you think it is that you would die if you become infected with COVID-19?"*). Participants estimated their perceived risk on a 5-point scale, ranging from 1 = very likely to 5 = not very likely. Low scores indicate a higher estimated probability of exposure to COVID-19 risk.

Perceived self-efficacy as a teacher in person and in distance teaching: The perceived self-efficacy as a teacher (TSE) was assessed by two scales for in-person and distance teaching environments. The scales were originally adopted from the short form of Ohio State Teacher Efficacy Scale (OSTES) [7] and resulted in a total of four subscales employed in the present study, with 4 items each. The scale consisted of four subscales: (a) self-efficacy in student engagement in in-person teaching (e.g., "*How much can you do to motivate students who show low interest in schoolwork?*"; *Cronbach's alpha* = 0.87); (b) self-efficacy in instruction in in-person teaching (e.g., "*To what extent can you craft good questions for your students?", Cronbach's alpha* = 0.82); (c) self-efficacy in student engagement in distance teaching (e.g., "*How much can you do to motivate students who show low interest in online schoolwork?", Cronbach's alpha* = 0.93); and (d) self-efficacy in instruction in distance teaching (e.g., "*To what extent can you craft good online questions for your students?", Cronbach's alpha* = 0.90). Teachers self-assessed their efficacy to handle the student engagement and instruction challenges on a 9-point scale, ranging from 1 = not at all to 9 = very much. High scores indicate a higher estimated TSE.

Relationship with technology: Relationship with technology was evaluated by 7 sub-scales from Teo's research [18,19]. To the original 25 items, 1 more single-item subscale was added to assess teachers' efficiency in use of the current platforms used in Greece for distance learning (e.g., "*I am able to use videoconferencing platforms such as Zoom, Skype, MS Teams etc.*"). The sub-scales (with high internal consistency) were: (a) experiencing assistance in the use of technology (3 items, e.g., "*When I encounter difficulties in using technology, a specific person is available to provide assistance*", *Cronbach's alpha* = 0.87); (b) perceived usefulness of technology (4 items, e.g., "*Using technology enables me to accomplish tasks more quickly*", *Cronbach's alpha* = 0.92); (c) perceived ease of use (5 items, e.g., "*I find it easy to use technology to do what I want to do*", *Cronbach's alpha* = 0.93); (d) basic technological skills acquired (3 items, *Cronbach's alpha* = 0.76) (e.g., "*I am able to use word processor to create, edit and format documents for specific purposes (e.g., Microsoft Word)"*); (e) advanced technological skills acquired (3 items, e.g., "*I am able to use video editing software (e.g., Microsoft Movie Maker, Adobe Premier, Ulead Video Studio)*", *Cronbach's alpha* = 0.89); (f) efficiency to apply pedagogical skills via technology (4 items, e.g., "*I am able to adopt and adapt given online technologies-based learning activities*", *Cronbach's alpha* = 0.88); and (g) behavioural intention to use technology further in the future (3 items, e.g., "*I intend to continue to use technology in the future*", *Cronbach's alpha* = 0.94).

Teachers assessed their efficiency and attitudes on a 7-point Likert scale from 1 = "*strongly disagree*" to 7 = "*strongly agree*". High scores indicate higher levels of efficiency and more positive attitudes towards technology.

3. Results

F-ANOVA tests were applied to investigate gender and status (in- and pre-service) differences among teachers. Mean scores, standard deviations and *F* scores are presented in Tables 1 and 2. Female teachers (Table 1) scored higher than males in their self-reported self-efficacy in distance learning environments, both in instructional ($\eta^2 = 0.02$) and in student engagement ($\eta^2 = 0.04$). Concerning risk perceptions of COVID-19, teachers expressed high levels of probable exposure to risk, concerning contamination and contamination in the school environment. Men scored higher in their perceptions of COVID-19 risk contamination ($\eta^2 = 0.03$), expressing fewer worries about their exposure to risk, especially concerning issues of contamination. In the facets of relationship with technology, gender differences were found in two out of eight facets, as women scored higher than men in their behavioral intention to use technology ($\eta^2 = 0.03$) and slightly lower in their self-assessed skills to use the current distant learning platforms ($\eta^2 = 0.02$).

Table 1. Mean scores (SD) for self-efficacy in in-person- and distance learning environments, COVID-19 Risk Perception Subscales and Relationship with Technology Subscales and F-ANOVA comparisons between men and women teachers.

	Men	***Women***	
	Mean (SD)	***Mean (SD)***	***F* (df)**
Self-efficacy in in-person teaching			
Instructional	28.60 (4.62) [n = 52]	29.17 (4.23) [n = 190]	0.73 (1, 240)
Student engagement	26.92 (4.87) [n = 52]	28.09 (4.74) [n = 189]	2.44 (1, 239)
Self-efficacy in in-distance teaching			
Instructional	22.10 (7.50) [n = 51]	24.47 (6.97) [n = 185]	4.54 * (1, 234)
Student engagement	21.22 (7.81) [n = 51]	24.43 (6.48) [n = 185]	8.98 ** (1, 234)
COVID-19 risk perception			
Risk of contamination	2.17 (0.67) [n = 52]	1.88 (0.69) [n = 187]	7.30 ** (1, 237)
Risk of death	3.19 (0.90) [n = 50]	3.13 (0.94) [n = 190]	0.17 (1, 238)
Risk in school environment	1.69 (0.92) [n = 52]	1.92 (0.96) [n = 189]	2.34 (1, 237)
Relationship with technology			
Facilitating condition	4.28 (1.64) [n = 51]	4.50 (1.64) [n = 187]	0.76 (1, 236)
Perceived usefulness	4.81 (1.60) [n = 48]	5.00 (1.38) [n = 186]	0.68 (1, 232)
Perceived ease of use	5.40 (1.24) [n = 52]	5.34 (1.35) [n = 182]	0.06 (1, 232)
Basic technological skills	6.47 (0.84) [n = 50]	6.55 (0.68) [n = 183]	0.50 (1, 231)
Advanced technological skills	3.31 (2.02) [n = 46]	3.38 (1.82) [n = 180]	0.05 (1, 224)
Technology for pedagogy skills	5.10 (1.39) [n = 50]	5.35 (1.25) [n = 184]	1.59 (1, 232)
Behavioral intention to use technology	5.54 (1.53) [n = 52]	6.06 (1.16) [n = 187]	6.82 ** (1, 237)
Platforms	6.64 (0.69) [n = 52]	6.25 (1.12) [n = 189]	5.55 * (1, 239)

Note: * $p < 0.05$, ** $p < 0.01$.

Table 2. Mean Scores (SD) for self-efficacy in in-person and distance learning environments, COVID-19 Risk Perception Subscales and Relationship with Technology Subscales and F-ANOVA comparisons between in-service and pre-service teachers.

	In-Service~Teachers	*Pre-Service Teachers*	
	Mean (SD)	***Mean (SD)***	***F* (df)**
Self-efficacy in in-person teaching			
Instructional	29.06 (4.49) [n = 176]	28.87 (4.16) [n = 90]	0.11 (1, 264)
Student engagement	27.41 (5.08) [n = 175]	28.74 (3.93) [n = 90]	4.73 * (1, 263)
Self-efficacy in in-distance teaching			
Instructional	23.26 (7.04) [n = 167]	25.62 (7.10) [n = 91]	6.54 * (1, 256)
Student engagement	22.76 (6.79) [n = 169]	26.13 (6.53) [n = 91]	15.00 ** (1, 258)
COVID-19 risk perception			
Risk of contamination	1.90 (.69) [n = 178]	2.05 (.71) [n = 97]	3.06 (1, 273)
Risk of death	3.11 (0.95) [n = 178]	3.18 (0.93) [n = 98]	0.40 (1, 274)
Risk in school environment	1.76 (0.89) [n = 180]	2.2 (1.00) [n = 98]	9.92 ** (1, 276)
Relationship with technology			
Facilitating condition	4.39 (1.75) [n = 165]	4.63 (1.43) [n = 89]	1.30 (1, 252)
Perceived usefulness	4.90 (1.47) [n = 162]	5.20 (1.29) [n = 88]	2.70 (1, 248)
Perceived ease of use	5.27 (1.33) [n = 161]	5.57 (1.28) [n = 89]	2.85 (1, 248)
Basic technological skills	6.58 (0.73) [n = 159]	6.44 (0.72) [n = 88]	2.13 (1, 245)
Advanced technological skills	3.23 (1.97) [n = 155]	3.78 (1.68) [n = 87]	4.91 * (1, 240)
Technology for pedagogy skills	5.29 (1.33) [n = 163]	5.35 (1.16) [n = 87]	0.13 (1, 248)
Behavioral intention to use technology	5.93 (1.35) [n = 167]	5.98 (1.06) [n = 88]	0.12 (1, 253)
Platforms	6.38 (1.05) [n = 167]	6.23 (1.11) [n = 90]	1.05 (1, 255)

Note: * $p < 0.05$, ** $p < 0.01$.

Pre-service teachers scored higher than in-service teachers (Table 2) in their self-efficacy beliefs concerning student engagement in in-person school settings ($\eta^2 = 0.02$) and in distance teaching instructional self-efficacy ($\eta^2 = 0.03$) and student engagement ($\eta^2 = 0.06$). Concerning teachers' relationship with technology, pre-service teachers scored higher than in-service only in the facet of advanced technology skills ($\eta^2 = 0.02$).

Correlations between the COVID-19 risk perceptions, facets of the relationship with technology, with the subscales of self-efficacy in in-person and in-distance learning environments were also calculated. As seen in Table 3, subscales of COVID-19 risk perception were only slightly correlated with teachers' self-efficacy in student engagement in in-person learning. Concerning the facets of the teachers' relationship with technology, these showed moderate positive correlations with teachers' self-efficacy in in-person teaching scores and stronger correlations with teachers' self-efficacy in distance teaching.

Table 3. Correlations Pearson r between scores of COVID-19 Risk Perception Subscales and Relationship with Technology Subscales.

	Self-Efficacy in In-Person Teaching		***Self-Efficacy in In-Distance Teaching***	
	Instructional	Student engagement	Instructional	Student engagement
COVID-19 risk perception				
Risk of contamination	0.01	0.11	−0.03	0.04
Risk of death	−0.11 *	−0.04	−0.09	−0.10 *
Risk in school environment	0.01	0.12 *	0.06	0.07
Relationship with technology				
Facilitating condition	0.15 **	0.14 *	0.28 **	0.24 **
Perceived usefulness	0.31 **	0.22 **	0.49 **	0.39 **
Perceived ease of use	0.32 **	0.23 **	0.53 **	0.40 **
Basic technological skills	0.34 **	0.20 **	0.31 **	0.22 **
Advanced technological skills	0.16 **	0.14 *	0.34 **	0.32 **
Technology for pedagogy skills	0.42 **	0.25 **	0.60 **	0.48 **
Behavioral intention to use technology	0.28 **	0.19 **	0.48 **	0.36 **
Platforms	0.31 **	0.13 *	0.32 **	0.25 **

Note: * $p < 0.05$, ** $p < 0.01$ (one-tailed).

To test our hypothesis about the role of positive relationship with technology in the perceived self-efficacy (in person and in distance teaching) within the context of COVID-19 risk perception situation (as teachers exhibit a high level of concern about COVID-19), a three-stage hierarchical multiple regression was conducted with the two subscales of self-efficacy (instructional and student engagement) in both in-person and distance learning environments.

As seen in Table 4, *instructional self-efficacy in traditional environments* was entered as a dependent variable. Gender and status of teaching were entered at stage one to control for demographic variables. The COVID-19 risk perceptions (risk of contamination, risk of death and risk in school environment) were entered at stage two and the facets of relationship with technology (facilitating condition, perceived usefulness, perceived ease of use, basic technological skills, advanced technological skills, technology for pedagogy skills, behavioral intention to use technology, and use of platforms) at stage three. β-Scores are presented in Table 4. The hierarchical multiple regression revealed that at stage one the demographic variables did not contribute significantly to the regression model, F (2, 185) = 0.83, $p > 0.05$. Introducing the risk of contamination variables did not add any significant change in the explained variation of the instructional self-efficacy in traditional educational settings (F (3, 182) = 1.26, $p > 0.05$). Adding the relationship with technology variables to the regression model, explained a 21% of the variation of self-efficacy ($R^2 = 0.21$, $R^2_{adjusted}$ 0.15, $R^2_{change} = 0.18$, F (8, 174) = 4.94, $p < 0.001$).

Accordingly, *student engagement self-efficacy in traditional environments* was entered as a dependent variable. Gender and status of teaching were entered at stage one of the control for demographic variables, the COVID-19 risk perceptions were entered at stage two and the facets of relationship with technology at stage three. β-Scores are also presented in Table 4. The hierarchical multiple regression revealed that at stage one the demographic variables contribute significantly to the regression model, and explained 4.8% of the variation of self-efficacy ($R^2 = 0.05$, $R^2_{adjusted}$ 0.04, F (2, 184) = 4.68, $p \leq 0.01$). Introducing the risk of contamination variables (F (3, 181) = 0.991, $p > 0.05$) at stage two, and the relationship with technology at stage three, did not add any further significant change in the explained variation of the student engagement self-efficacy in traditional educational settings, F (8, 173) = 1.51, $p > 0.05$.

Table 4. Summary of the final results of hierarchical regression: β-scores.

Final β	Dependent Variables			
Variables	Self-Efficacy in In-Person Teaching		Self-Efficacy in Distance Teaching	
	Instructional	Student engagement	Instructional	Student engagement
*Step 1; Gender * Teacher's status*				
Gender (1 = man, 2 = woman)	0.09	0.08	0.14 *	0.16 *
Teacher's status (1 = in-service, 2 = pre-service)	0.01	0.20 **	0.19 **	0.29 **
Step 2; COVID-19 risk perception				
Gender	0.10	0.10	0.14	0.18 *
Teacher's status	−0.02	0.17 *	0.17 *	0.27 **
Risk of contamination	0.05	0.09	−0.02	0.10
Risk of death	−0.14	−0.10	−0.09	−0.11
Risk in school environment	0.07	0.05	0.08	−0.02
Step 3; Relationship with technology				
Gender	0.08	0.07	0.12	0.16 *
Teacher's status	0.01	0.18 *	0.12 *	0.24 **
Risk of contamination	0.00	0.04	−0.07	0.06
Risk of death	−0.14	−0.09	−0.08	−0.10
Risk in school environment	0.06	0.05	0.03	−0.06
Facilitating condition	−0.02	−0.06	0.04	0.04
Perceived usefulness	0.05	0.02	0.12	0.08
Perceived ease of use	−0.06	0.00	0.17	0.05
Basic technological skills	0.17 *	0.11	−0.04	−0.03
Advanced technological skills	−0.05	−0.02	0.02	0.04
Technology for pedagogy skills	0.26 *	0.22 *	0.46 **	0.36 **
Behavioral intention to use technology	−0.02	−0.05	−0.08	−0.05
Platforms	0.17	−0.02	0.03	0.06

Note: * t-value significant $p < 0.05$, ** t-value significant $p < 0.01$.

The *instructional self-efficacy in distance learning environments* followed to enter as a dependent variable. The hierarchical multiple regression revealed that at stage one the demographic variables contribute significantly to the regression model, and explained 6.2% of the variation in self-efficacy, $R^2 = 0.05$, $R^2_{adjusted}$ 0.04, F (2, 182) = 6.02, $p < 0.005$. Introducing the risk of contamination variables did not add any significant change in the explained variation of the instructional self-efficacy in digital educational settings, F (3, 179) = 0.73, $p > 0.05$. Adding the relationship with technology variables to the regression model explained 46.9% of the variation in self-efficacy, $R^2 = 0.47$, $R^2_{adjusted}$ 0.43, $R^2_{change} = 0.40$, F (8, 171) = 15.94, $p < 0.001$.

Finally, *the teachers' engagement self-efficacy in distance learning contexts* was entered as a dependent variable. The hierarchical multiple regression revealed that at stage one the demographic variables contributed significantly to the regression model and explained 12% of the variation in self-efficacy, $R^2 = 0.12$, $R^2_{adjusted}$ 0.11, F (2, 182) = 12.45, $p < 0.001$. Introducing the risk of contamination variables did not add any significant change in the explained variation of the instructional self-efficacy in digital educational settings, F (3, 179) = 0.91, $p > 0.05$. Adding the relationship with technology variables to the regression model, explained 34.5% of the variation in self-efficacy, $R^2 = 0.34$, $R^2_{adjusted}$ 0.30, $R^2_{change} = 0.40$, F (8, 171) = 6.90, $p < 0.001$.

According to β-scores (as presented in Table 4), at stage three, teacher's status (pre- or in-service) seem to have a predictive validity to teachers' self-efficacy, as preservice teachers seem to report higher levels of self-efficacy, both in instructional and in student engagement, especially in distance learning environments, and among all eight facets of relationship with technology, higher scores in their self-assessed skills of the pedagogical

applications of technology seem to better predict higher levels of self-efficacy, in distance learning environments particularly.

4. Discussion

The purpose of this study was to explore teachers' instructional and engagement self-efficacy beliefs in both online and face-to-face teaching during COVID-19 and to investigate the role of teachers' relationships with technology and COVID-19 risk perception on their perceived self-efficacy. We found that gender and teaching status (in-service versus non-in-service) were implicated in self-efficacy beliefs. Perceptions of COVID-19 were not a significant predictor of self-efficacy but a positive relationship with technology associated with perceived self-efficacy in both traditional and distance learning environments.

Analysis showed gender differences concerning teachers' perceived self-efficacy and relationships with technology, as per social cognitive career theory [20]. Female teachers scored higher than males in their self-reported instructional and engagement efficacy in distance learning environments. Even though the literature lacks clarity with regards to gender differences in teachers' self-efficacy, our results are consistent with a line of research showing female teachers reporting higher self-efficacy [21,22]. The higher self-efficacy beliefs of female teachers have been attributed to cultural expectations as well as gender-role socialization experiences [23]. Males showed higher scores in their self-assessed skills to use the distant learning platforms, which was expected, as previous research revealed that males tend to regard themselves as more competent than females when evaluating their ICT skills [24]. These findings about gender differences align with previous studies conducted in the past and contribute to these scholarly works by providing novel piece of evidence in the context of emergency remote education.

Contrary to Pressley and Ha [25] who found no association between teaching status and TSE during COVID-19, our data showed that pre-service teachers scored higher than in-service teachers self-efficacy beliefs in both face-to-face and distance learning. Our results corroborated previous findings that have found a similar association between with self-efficacy scores and teaching experience [26,27]. Hoy and Spero [26] suggested that prospective and novice teachers gain confidence in their teaching skills through their early years because they underestimate the complexity of the teaching task and that these levels of confidence may decline as they acquire more teaching experience. It is also possible that experienced teachers reported lower self-efficacy because they had to re-assess their self-efficacy skills due to the new challenges posed by the COVID-19 teaching adaptations. In contrast, for novice teachers, this sudden transition might not have had the same impact on the assessment of their self-efficacy because they had not yet consolidated their daily teaching routines and experiences. Furthermore, many pre-service teachers may be part of the "net generation" that already actively use technology in everyday living [28].

Our study also revealed that teachers expressed high levels of concern regarding COVID-19 infection and fear of contamination in the school environment. Even though only a few studies have examined risk perception in teachers during the pandemic, our results are similar to findings from Germany and Taiwan [13,29]. We also found that females had more significantly higher odds of being more concerned about their exposure to risk, especially fear of contamination, than their male colleagues, which is consistent with the German data [29]. These gender differences can be explained by females' greater concern about their health and safety in the working environment as well as generally higher levels of anxiety [30,31]. Interestingly, even though perceived probability of exposure to COVID-19 among teachers was high, COVID-19 risk perception was not a significant predictor of any aspect of TSE. This is in contrast to previous studies that found an association between risk perception and general self-efficacy [13,14]. In our study we measured TSE (rather than general self-efficacy), and therefore our finding could be attributed to the fact that most teachers at the time of data collection were in confinement, and therefore their instructional and engagement self-efficacy were not directly impacted by perceived risk of exposure to COVID-19.

Our results showed that a positive relationship with technology, particularly technology for pedagogy skills, predicted TSE in both traditional and distance learning environments; this association is especially pertinent to pre-service teachers. Therefore, the strongest predictor of our sample's high TSE beliefs in the context of the COVID-19 pandemic seemed to be mastery experiences, consistent with Bandura's views [6] and in line with similar results that revealed that positive effect of perceived digital competence on teachers' self-efficacy [32].These results are also consistent with previous findings that showed that training teachers about integrating ICT into teaching and learning might enhance the self-beliefs of their capabilities [33]. We propose, in agreement with Smarkola's [34] argument that teacher ICT training should be specifically tailored toward the content-specific use of computers in classroom instruction instead of purely basic operational computer skills. In this vein, helping teachers to experience mastery through technology supported education training would enable them to take advantage of innovative technology-based teaching methods and it would also enhance their TSE.

5. Conclusions

Based on our results, we may conclude that skills of the pedagogical applications of technology seem to predict higher levels of teacher self-efficacy in both face-to-face and in distance learning environments. However, our study has some limitations, the first one being the sample size and the recruitment of teachers for the online survey. The sample that took part in our study was not so large and may have been affected by self-selection bias. Another limitation is that only the teaching status of teachers was investigated as a situational factor, resulting to a limited picture regarding the study of the contribution of other situational parameters. Additionally, data collection occurred at a single time point. Future research should continue to investigate the longitudinal impact of COVID-19 on teachers' self-efficacy. Such a study would allow us to explore reciprocal relations between technology integration in education and self-efficacy as well as how these may have impacted other types of teacher behaviors during the COVID-19 pandemic. Triangulating/multistep methods, including focus group interviews to validate the results, would also be beneficial.

Irrespective of these limitations, the current study shows how teachers felt during a crucial moment in education. This study emphasizes the need for teacher professional development in remote teaching and technology competencies to support and improve teachers' perceived self-efficacy. We urge others to continue exploring the impact of teaching during the post COVID-19 era in order to begin to generalize findings. Given that education may never return to a fully pre-pandemic approach, and beyond COVID-19, other natural disasters or crises may disrupt schools periodically in the future, we recommend that it become a priority to promote pedagogy-specific technological skills to promote teachers' self-efficacy. It is essential that teachers are offered specific technological skills that apply to pedagogical settings, along with the general computer training programs. Teachers' positive technology integration has both immediate and long-term implications for their self-efficacy, making this study's findings relevant in the context within and beyond COVID-19.

Author Contributions: Conceptualization, E.A., L.M. and A.G.; methodology, C.R.; software, C.R.; validation, C.R. and L.M.; formal analysis, C.R.; investigation, E.A. and C.R.; resources, L.M. and A.G.; data curation, C.R. and S.T.; writing—original draft preparation, C.R., S.T. and E.A.; writing—review and editing, E.A., L.M. and A.G.; visualization, C.R. and S.T.; supervision, E.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of THE UNIVERSITY OF THESSALY (P.C.: 21/ 10.09.2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author, (E.A.).

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Daniel, S.J. Education and the COVID-19 pandemic. *Prospects* **2020**, *49*, 91–96. [CrossRef] [PubMed]
2. Huber, S.G.; Helm, C. COVID-19 and schooling: Evaluation, assessment and accountability in times of crises—Reacting quickly to explore key issues for policy, practice and research with the school barometer. *Educ. Assess. Eval. Account.* **2020**, *32*, 237–270. [CrossRef] [PubMed]
3. Rabaglietti, E.; Lattke, L.S.; Tesauri, B.; Settanni, M.; De Lorenzo, A. A balancing act during COVID-19: Teachers' self-efficacy, perception of stress in the distance learning experience. *Front. Psychol.* **2021**, *12*, 644108. [CrossRef] [PubMed]
4. Pressley, T. Returning to teaching during COVID-19: An empirical study on elementary teachers' self-efficacy. *Psychol. Sch.* **2021**, *58*, 1611–1623. [CrossRef]
5. Armor, D.; Conry-Oseguera, P.; Cox, M.; King, N.; McDonnell, L.; Pascal, A. *Analysis of the School Preferred Reading Program in Selected Los Angeles Minority Schools*; Rand Corporation: Santa Monica, CA, USA, 1976.
6. Bandura, A. *Self-Efficacy: The Exercise of Control*; W H Freeman/Times Books/Henry Holt & Co.: New York, NY, USA, 1997.
7. Tschannen-Moran, M.; Hoy, A.W. Teacher efficacy: Capturing an elusive construct. *Teach. Teach. Educ.* **2001**, *17*, 783–805. [CrossRef]
8. Nikolopoulou, K.; Gialamas, V. Barriers to ICT use in high schools: Greek teachers' perceptions. *J. Comput. Educ.* **2016**, *3*, 59–75. [CrossRef]
9. Mailizar, M.; Almanthari, A.; Maulina, S.; Bruce, S. Secondary school mathematics teachers' views on e-learning implementation barriers during the COVID-19 pandemic: The case of Indonesia. *Eurasia J. Math. Sci. Technol. Educ.* **2020**, *16*, 1860. [CrossRef]
10. Baroudi, S.; Shaya, N. Exploring predictors of teachers' self-efficacy for online teaching in the Arab world amid COVID-19. *Educ. Inf. Technol.* **2022**, *27*, 8093–8110. [CrossRef]
11. Ogodo, J.A.; Simon, M.; Morris, D.; Akubo, M. Examining K-12 teachers' digital competency and technology self-efficacy during COVID-19 pandemic. *J. High. Educ. Theory Pract.* **2021**, *21*, 13–27. [CrossRef]
12. Nabe-Nielsen, K.; Fuglsang, N.V.; Larsen, I.; Nilsson, C.J. COVID-19 risk management and emotional reactions to COVID-19 among school teachers in Denmark: Results from the CLASS study. *J. Occup. Environ. Med.* **2021**, *63*, 357–362. [CrossRef]
13. Tang, J.-S.; Chen, C.-L.; Lin, C.-H.; Feng, J.-Y. Exploring teachers' risk perception, self-efficacy and disease prevention measures during the outbreak of 2019 novel coronavirus disease in Taiwan. *J. Infect. Public Health* **2021**, *14*, 358–364. [CrossRef] [PubMed]
14. Yenen, E.T.; Çarkit, E. Fear of COVID-19 and general self-efficacy among Turkish teachers: Mediating role of perceived social support. *Curr. Psychol.* **2021**, 1–9. [CrossRef] [PubMed]
15. Wolters, C.A.; Daugherty, S.G. Goal structures and teachers' sense of efficacy: Their relation and association to teaching experience and academic level. *J. Educ. Psychol.* **2007**, *99*, 181–193. [CrossRef]
16. Klassen, R.M.; Chiu, M.M. Effects on teachers' self-efficacy and job satisfaction: Teacher gender, years of experience, and job stress. *J. Educ. Psychol.* **2010**, *102*, 741–756. [CrossRef]
17. Gerhold, L. COVID-19: Risk perception and coping strategies. *PsyArXiv* **2020**. [CrossRef]
18. Teo, T. Modelling technology acceptance in education: A study of pre-service teachers. *Comput. Educ.* **2009**, *52*, 302–312. [CrossRef]
19. Teo, T. Factors influencing teachers' intention to use technology: Model development and test. *Comput. Educ.* **2011**, *57*, 2432–2440. [CrossRef]
20. Lent, R.W.; Brown, S.D.; Hackett, G. Contextual supports and barriers to career choice: A social cognitive analysis. *J. Couns. Psychol.* **2000**, *47*, 36–49. [CrossRef]
21. Gundogmus, H.D. Self-efficacy of teacher candidates for teaching first reading and writing. *Educ. Res. Rev.* **2018**, *13*, 224–229. [CrossRef]
22. Raudenbush, S.W.; Rowan, B.; Cheong, Y.F. Contextual effects on the self-perceived efficacy of high school teachers. *Sociol. Educ.* **1992**, *65*, 150. [CrossRef]
23. Perera, H.N.; Calkins, C.; Part, R. Teacher self-efficacy profiles: Determinants, outcomes, and generalizability across teaching level. *Contemp. Educ. Psychol.* **2019**, *58*, 186–203. [CrossRef]
24. Cooper, J. The digital divide: The special case of gender: The digital divide. *J. Comput. Assist. Learn.* **2006**, *22*, 320–334. [CrossRef]
25. Pressley, T.; Ha, C. Teaching during a pandemic: United States teachers' self-efficacy during COVID-19. *Teach. Teach. Educ.* **2021**, *106*, 103465. [CrossRef] [PubMed]
26. Hoy, A.W.; Spero, R.B. Changes in teacher efficacy during the early years of teaching: A comparison of four measures. *Teach. Teach. Educ.* **2005**, *21*, 343–356. [CrossRef]
27. Cataudella, S.; Carta, S.M.; Mascia, M.L.; Masala, C.; Petretto, D.R.; Agus, M.; Penna, M.P. Teaching in Times of the COVID-19 Pandemic: A Pilot Study on Teachers' Self-Esteem and Self-Efficacy in an Italian Sample. *Int. J. Environ. Res. Public Health* **2021**, *18*, 8211. [CrossRef]
28. Menabò, L.; Skrzypiec, G.; Sansavini, A.; Brighi, A.; Guarini, A. Distance education among Italian teachers: Differences and experiences. *Educ. Inf. Technol.* **2022**, *27*, 9263–9292. [CrossRef]

29. Weinert, S.; Thronicke, A.; Hinse, M.; Schad, F.; Matthes, H. School teachers' self-reported fear and risk perception during the COVID-19 pandemic—A nationwide survey in Germany. *Int. J. Environ. Res. Public Health* **2021**, *18*, 9218. [CrossRef]
30. Slimak, M.W.; Dietz, T. Personal values, beliefs, and ecological risk perception. *Risk Anal.* **2006**, *26*, 1689–1705. [CrossRef]
31. McLean, C.P.; Asnaani, A.; Litz, B.T.; Hofmann, S.G. Gender differences in anxiety disorders: Prevalence, course of illness, comorbidity and burden of illness. *J. Psychiatr. Res.* **2011**, *45*, 1027–1035. [CrossRef]
32. Gobbi, E.; Bertollo, M.; Colangelo, A.; Carraro, A.; di Fronso, S. Primary School Physical Education at the Time of the COVID-19 Pandemic: Could Online Teaching Undermine Teachers' Self-Efficacy and Work Engagement? *Sustainability* **2021**, *13*, 9830. [CrossRef]
33. Scherer, R.; Siddiq, F. Revisiting teachers' computer self-efficacy: A differentiated view on gender differences. *Comput. Hum. Behav.* **2015**, *53*, 48–57. [CrossRef]
34. Smarkola, C. Efficacy of a planned behavior model: Beliefs that contribute to computer usage intentions of student teachers and experienced teachers. *Comput. Hum. Behav.* **2008**, *24*, 1196–1215. [CrossRef]