Teacher training as a strategy to prevent technostress and the violation of work-family limits in K-12 teachers

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Abstract
The growing use of information and communication technologies in the educational context has led to technostress (also known as technological stress – a negative psychological state caused by excessive or inappropriate use of information and communication technologies), which affects the mental health of teachers. This study examined the relationship between technostress and work-family conflict in 455 teachers of K-12, considering the characteristics of both the public and private sectors. The results indicate that teachers in public schools experienced higher levels of technostress, while teachers in private schools showed higher levels of inhibition to this technological stress. The findings of this study may be useful for school managers in implementing strategies such as flexibility policies, digital self-monitoring support, and training on the use of information and communication technologies, in order to mitigate the effects of technostress. However, future research with longitudinal designs is needed to deepen the understanding of this relationship.

Keywords
tecno-stress; teachers; k-12 education; work e family.

A formação docente como estratégia para prevenir o tecnoestresse e a violação de limites trabalho-família em professores da educação básica

Resumo
O uso crescente de tecnologias de informação e comunicação no contexto educacional tem gerado o *tecnoestresse* (também conhecido como estresse tecnológico – um estado psicológico negativo causado pelo uso excessivo ou inadequado de tecnologias de informação e comunicação), que afeta a saúde mental dos professores. Este estudo examinou a relação entre *tecnoestresse* e conflito trabalho-família em 455 professores da educação básica, levando em consideração as características dos setores público e privado. Os resultados indicam que os professores de escolas públicas apresentaram níveis mais elevados de *tecnoestresse*, enquanto os professores de escolas privadas apresentaram níveis mais altos de inibição a esse estresse tecnológico. As descobertas deste estudo podem ser úteis para os gestores escolares na implementação de estratégias como políticas de flexibilidade, suporte de automonitoramento digital e treinamento sobre o uso de tecnologias de informação e comunicação, a fim de mitigar os

efeitos do *tecnoestresse*. No entanto, pesquisas futuras com delineamentos longitudinais são necessárias para aprofundar a compreensão dessa relação.

Palavras-chave
tecnoestresse; professores; educação básica; trabalho e família.

La formación del profesorado como estrategia para prevenção el tecnoestrés y la violación de los límites trabajo-familia en la educación básica

Resumen
El creciente uso de las tecnologías de la información y la comunicación en el contexto educativo ha provocado tecnoestrés (también conocido como estrés tecnológica, un estado psicológico negativa causa por el uso excesivo o inadecuado de las tecnologías de la información y la comunicación), que afecta a la salud mental de los profesores. Esta investigación analizó el tecnoestrés y el conflicto trabajo-familia entre 455 profesores de primaria y secundaria, comparando las experiencias de los educadores del sector público y privada. Los resultados indican que los profesores de la escuela pública mostraron mayores niveles de tecnoestrés, mientras que los de la privada mostraron mayores niveles de inhibición contra este estés tecnológica. Los resultados de este estudio pueden ser útiles para que los líderes escolar implementen estratégias como políticas de flexibilidad, apoyo al autocontrol digital y formación en el uso de las tecnologías de la información y la comunicación para mitigar los efectos del tecnoestrés. Sin embargo, son necesarias futuro investigaciones con diseños longitudinales para profundizar en el conocimiento de esta relación.

Palabras clave
tecnoestrés; profesores; educación básica; trabajo y familia.

1. Introduction

In the modern workplace, the ubiquitous use of technology can present both opportunities and challenges for workers (Tuan, 2022). While technological advances have increased efficiency and made remote work possible, they have also introduced new sources of stress. In this environment, it has become necessary for workers, including teachers, to have more knowledge about the use of information and communication technologies (ICT). This need for knowledge, the demand for improvement, low autonomy and the requirement to be connected most of the day cause a stressful effect known as *technostress* (Goebel; Carlotto, 2019).

Technostress, a term used to describe the negative psychological effects of overuse of technology, has become a growing problem. The factors contributing to this phenomenon include: (I) technical overload, when professionals are required to work long

hours and as quickly as possible; (II) technical invasion, when employees are contacted at any time, even outside of working hours; (III) technical complexity, when not all workers have received specific training to acquire knowledge related to ICTs, which are inherently complex; (IV) techno-insecurity, when professionals face the risk of losing their jobs due to technological advancements; and (V) techno-insecurity, when employees experience discomfort and insecurity due to the constant changes in how technologies are used and learned (Ragu-Nathan et al., 2008).

The study by Ragu-Nathan et al. (2008) identified barriers to technostress: (I) promoting literacy, where workers learn to use ICTs, leading to an exchange of information among professionals that supports their learning and reduces technostress; (II) providing technical support, which offers security and assistance to users, ensuring they know who to turn to in case of questions or issues; (III) workplace involvement, which brings workers closer to information and involves the integration of new technologies within the work environment (Ragu-Nathan et al., 2008).

Although technology and connectivity have promoted the continuity of work, autonomy and flexibility of schedules, as well as activities in times of the Covid-19 pandemic, teachers felt pressured to work more, which negatively impacted their health and the quality of work relationships (Cipriani; Moreira; Carius, 2021). It is important to emphasize that technostress can manifest in different ways and directly impact the delicate boundary between work and personal life (Pinho *et al.*, 2021).

Work and family are a mutual conflict and, in some respects, become incompatible when there is pressure from work and family roles (Aguiar; Bastos, 2013). Such conflict can arise through time, tension or behavior (Greenhaus; Beutell, 1985). Through time, it occurs when there is a dispute between the time to fulfill the expectations of the work and that dedicated to the family (Moreira; Silva, 2018). On the other hand, tension can manifest itself in the form of stress, anxiety and irritability and can be caused by spending too much time in one of the roles or by stressful and demanding tasks (Takahashi *et al.*, 2013). Finally, behavioral conflicts can occur when individuals fail to separate and adapt their behavior to different roles and functions (Greenhaus; Beutell, 1985).

In this sense, recent research points out that, although technology facilitates communication and flexibility at work, it also contributes to the violation of these limits and, thus, exacerbates the conflict between work and family (Goebel; Carlotto, 2019; Teixeira,

2022). The constant accessibility of emails and after-hours work messages can prevent individuals from completely disengaging from their work commitments, making it difficult to maintain a clear separation between the spheres of work and family (Derks *et al.*, 2015). This intrusion of work into family life can lead to emotional exhaustion, stress, and reduced satisfaction in both work and personal life.

Thus, violating the boundaries between work and family affects not only individuals but also organizations. Workers who face high levels of conflict in these spheres of their lives tend to have lower job performance, higher rates of absenteeism and greater intention to leave the organization (Oliveira; Cavazotte; Paciello, 2013), so it is in the interest of organizations to develop strategies and measures that promote a work-life balance, not only for the well-being of workers, but also for efficiency and talent retention.

It should be emphasized that technology has significantly transformed educational processes, being, therefore, indispensable for the work of teachers (Pereira; Silva; Novello, 2018), however, the lack of training for its pedagogical use causes discomfort among teachers, often generating technostress (Carvalho; d'Angelo, 2021). This problem was aggravated by the intensive use of ICT, especially during the Covid-19 pandemic, when teachers faced a lack of resources and increased workload, affecting well-being, as well as possibly contributing to burnout and lower engagement (Techio; Andrade; Oliveira, 2021).

Previous studies had already indicated a worsening in teachers' health problems in the period before the pandemic (Araújo; Pinho; Masson, 2019; Cipriani; Moreira; Carius, 2021). Mental illness was a problem at various levels of the educational system (Campos; Véras; Araújo, 2020).

Given the increasing use of ICT in the educational environment, therefore, the study of technostress factors in K-12 teachers is extremely relevant. The current scenario, arising from the Covid-19 pandemic, has exacerbated the dependence on these technologies, exposing teachers to new challenges and new tensions. Previous research has shown that the lack of adequate training for the pedagogical use of ICT, combined with the scarcity of resources and the increase in workload, negatively affects the well-being of teachers, thus generating exhaustion and reduced commitment (Pereira; Silva; Novello, 2018).

The relevance of this study, therefore, is reinforced by the deterioration of the mental health of teachers at different levels of education, as shown by several studies

(Campos; Véras; Araújo, 2020; Cipriani; Moreira; Carius, 2021; Silva; Oliveira, 2019; Souza; Taborda; Freitas, 2021). Moreover, the pandemic exacerbated psychological effects, whose consequences will likely persist for a long time (Ornell *et al.*, 2020). In the context of technostress, the literature is still limited, especially with regard to K-12 teachers (Moreno *et al.*, 2020). Thus, it is understood that the investigation of *technostress* factors and their consequences in K-12 teachers is essential for the development of effective interventions that can improve the well-being and quality of teaching.

This study examined the relationship between technostress and work-family conflict in K-12 teachers, taking into account the characteristics of the public and private sectors. The predictors of technological stress are identified and the prevalence in different educational systems (municipal, public and public-private schools) is analyzed. The results of this study can alert educational managers to the importance of developing strategies, as well as training programs that allow teachers to effectively integrate technology into their pedagogical practice and thus improve the quality of teaching. Measures to promote work-life balance, such as clear restrictions on availability and support for digital self-regulation, are essential to mitigate the negative impact of technological stress on individuals and organizations.

2. Methodology

Participants

This is a cross-sectional, descriptive and analytical study with a quantitative approach. The sample consisted of 455 K-12 teachers from public or private regular education institutions working in Brazil during the Covid-19 pandemic. Of the total sample, 89.5% were women (n = 407), and most were between 40 and 65 years old, representing 62.2% (n = 283), and 37.1% (n = 169) were between 21 and 39 years old. Of the total participants, 16.4% (n = 75) were single, while 60.4% (n = 275) reported being married and 13% (n = 59) were in a serious relationship. In terms of children, 59.2% (n = 209) had two or three children and 39.1% (n = 138) had only one child; and 84% (n = 382) lived with their partner and/or children.

Regarding organizational aspects, 22.2% (n = 101) of respondents worked up to 20 hours per week, while 61.3% (n = 279), the majority, worked between 21 and 40 hours per week. Of the participants, 66.4% (n = 302) worked in the municipal public school system, 24.8% (n = 113) worked in the state public school system and 8.8% (n = 40) worked in the private education system.

In addition, they also indicated how they had acquired their ICT knowledge. The majority, 37.4% (n = 170), acquired this knowledge by practicing on their own computer, without any special training. Another 31% (n = 141) acquired additional knowledge through training at the school where they worked and 18.2% (n = 83) sought courses on their own initiative. A smaller portion, 5.1% (n = 23), acquired knowledge in ICT in other ways, while 8.4% (n = 38) reported not having had specific training.

The following inclusion criteria were considered in the research: to carry out pedagogical activities at home, during the period of social distancing required by the Covid-19 pandemic; to work directly with students in the classroom or in the school administration. Teachers on leave due to physical or mental illness, on maternity leave, who had resigned or were acting as temporary or substitute teachers were excluded.

Instruments

For data collection, a sociodemographic questionnaire was created, which consisted of questions that dealt with the following topics: age, gender, educational background, hours worked per week, use of technological resources in the classroom in relation to the pandemic and before the pandemic. In addition to the questionnaire, other instruments were used, described below.

Work-Family Conflict Scale (WFC). To assess the presence of boundary violations at work and at home, was used the Hunter, Clark and Carlson (2019) scale, developed for this purpose. These authors created three items in order to assess boundary violations at work: (I) “Family life interrupted my work more than I would have liked”; (II) “Family life violated my work-family boundaries more than I would have liked”; and (III) “I found it mentally exhausting to switch from my work role to my family role.” These questions have been rewritten to focus on the violation of family by work. Cronbach's alpha of the original scale was 0.95 (Hunter; Clark; Carlson, 2019) and, in the present study, alpha = 0.903. For

each item, participants were asked to indicate their level of agreement on a 5-point Likert scale, where 1 represented “strongly disagree” and 5 “strongly agree”.

Technostress *scale* In the present study, the scale proposed by Ragu-Nathan *et al.* (2008) was used, which consists of questions that evaluated the construct through two dimensions categorized into three factors: generating factors (techno-overload + techno-invasion; techno-complexity + techno-insecurity) and technostress inhibitory factors (facilitating literacy + facilitating participation). In the reliability analysis of the original scale, all constructs presented Cronbach's alpha values between 0.91 and 0.71, thus reaching the minimum recommended. In the present research, the reliability was 0.86. For each statement, participants indicated the degree of agreement with the situations described. To this end, a five-point Likert scale was used, ranging from total agreement (5) to total disagreement (1).

Ethical data collection and care procedures

Data were collected through an online questionnaire, created through the Qualtrix tool and distributed via social media (Facebook, LinkedIn and WhatsApp); *emails* were collected from school websites, forming a random sample. The survey was conducted online between July 2020 and July 2021, a period characterized by the Covid-19 pandemic. To answer the questionnaire, participants agreed to the free and informed consent form. The research was approved by the Research Ethics Committee.

Data analysis procedures

First, missing data and outliers were checked and treated. Then, descriptive analyzes were performed (mean, mode, median, standard deviation, variance and amplitude) and the total scores of the analyzed factors were calculated according to the theoretical models and the evidence of validity of the versions of the measures in Brazil. The Shapiro-Wilk test was used to verify data normality. The reliability of the sample was verified by Cronbach's alpha coefficient (α), which evaluates the internal consistency of a scale by correlating its items (Cortina, 1993). On the other hand, the relationships between continuous variables were measured by Spearman's correlation, when a deviation from

normality was found. Non-parametric test, Kruskal-Wallis, was also used, because the data of the variables under study did not present normal distribution. In addition, Spearman's non-parametric correlation coefficient was used in order to evaluate the presence and intensity of the association between the variables studied. Multiple linear regression analysis was used to examine the predictors of “Work-Family Boundary Violation” and “Work-Family Boundary Violation”. The significance level was set at 5%. Statistical analyses were performed with IBM SPSS Statistics - Statistical Package for Social Sciences, version 27.

3. Results and Discussion

A comparative analysis of technostress factors was carried out through the education networks (municipal, state and private), in which teachers perform their functions (Table 1). After analyzing the factors, some were grouped, with two as predictors of technological stress: technological overload + technological invasion and technological complexity + technological insecurity. A factor that inhibited technostress was literacy + involvement.

In this sense, the Kruskal-Wallis statistical analysis showed that both techno-overloading and techno-invasion showed statistically significant differences between education networks. State public school teachers had the highest average score (26.1), followed by private school teachers (24.0) and municipal school teachers (22.5). Thus, it appears that teachers in public schools have a higher incidence of overload and technological invasion than the other networks analyzed. This suggests that these teachers work for long periods of time, quickly. In addition, they tend to be contacted more frequently and after-hours (Ragu-Nathan *et al.*, 2008). On the other hand, techno- complexity and techno-insecurity did not differ between the networks surveyed.

Regarding the inhibition factor, the extracted data revealed that private schools have a greater inhibition related to technical stress. This result suggests that such educational institutions may be offering greater technical support and training to their teachers in order to facilitate the use of ICT. Some authors point out that the availability of training and technical support programs is essential to reduce technostress, since it

increases familiarity and trust, thus reducing perceived techno-complexity (Goebel; Carlotto, 2019).

Table 1 – Prevalence of *technostress* in K-12 teachers of the three education networks (public municipal, public state and private)

Technogical Overload + Technogical invasion	**Average**	**DP**	**Test**	***p***
Performance Network				
Municipal Schools	22,5	5,88	H = 0.07612	<0,001
Public State	26.1	4,71		
Private	24,0	6,92		
Technological complexity + Technological insecurity				
Performance Network				
Municipal Schools	20.1	5.58	H = 0.01322	0.050
Public State	21.3	5.56		
Private	19,3	6.47		
Inhibitors Literacy + Involvement				
Performance Network				
Municipal Schools	13.6	3,36	H = 0.01415	0,041
Public State	14.3	3.45		
Private	14,4	3.93		

H, Kruskal-Wallis test; SD, standard deviation.
Source: Prepared by the authors (2024).

In addition, the variables were correlated, as shown in Table 2. It should be noted that some variables were not significant, such as age in relation to the number of hours taught (r = -0.072), contractual workload (r = -0.082), overload + invasion (r = 0.020) and literacy + commitment (r = -0.031). Thus, the absence of this correlation suggests that these elements do not influence each other. In the literature, such variables are generally more influenced by contextual and organizational factors than those related to age (Day *et al.*, 2017).

However, there was a significant positive correlation between age and techno-complexity and techno-insecurity (r = 0.275, p < 0.001). It has been found that as age increases, perceptions of complexity and insecurity also tend to increase. This fact suggests that older teachers tend to have greater techno-complexity and techno - insecurity. This result is in line with other studies, which found that older workers are less comfortable with new technologies due to less familiarity and confidence (Goebel; Carlotto, 2019; Pereira; Silva; Novello, 2018).

On the other hand, the contractual workload did not show significant correlations with techno-overload + techno-invasion *(* r = 0.087), techno-complexity + techno- insecurity (r = -0.037) and inhibitory competence + involvement (r = -0.060). However, the variable

techno-overload + techno-invasion showed a significant positive correlation with techno-complexity + techno-insecurity ($r = 0.504$, $p < 0.001$), indicating that a greater perception of overload and invasion is associated with greater complexity and insecurity.

The factors that inhibit technostress, literacy and involvement presented negative significance in relation to their predictor variables. This negative correlation suggests that more committed teachers, as well as those who acquire more knowledge through the use of ICT, presented less technostress. On the other hand, techno-overload and techno-invasion, when added, can limit the ability of teachers to engage in training and technological development programs, reducing their effectiveness, thus increasing technostress (Derks *et al.*, 2015; Teixeira, 2022). Likewise, the techno-complexity *and* techno-insecurity associated *with* ICT can limit employees from actively participating in the technological sphere, thus restricting their technological competence (Carlotto; Câmara, 2010).

Table 2 – Correlation matrix

	1	2	3	4	5	6
1. Age	—					
2. Number of hours in the classroom	-0.072	—				
3. Contractual workload	-0,082	0.611***	—			
4. Technological Overload + Technological Invasion	0.020	0.069	0.087	—		
5. Technological complexity + Technological Insecurity	0.275***	0.035	-0,037	0.504***	—	
6. Inhibitor Literacy + involvement	-0.031	-0.025	-0.060	-0.178***	-0.199***	—

Note. * p < .05, ** p < .01, *** p < .001

Source: Prepared by the authors (2024).

In addition, a linear regression analysis was performed in order to examine the transposition of limits from the perspective of family and work. The results revealed a coefficient of determination R^2 of 0.255, indicating that 25.5% of the variability of border violation can be explained by the variables included in the model.

Table 3 shows the variables that can influence the outcome variable: the violation of family-work limits. In this sense, the data obtained through the analysis demonstrate that

teachers aged between 40 and 65 years have a significant negative estimate of -0.9142 (t = -3.170, p = 0.002), suggesting that this age group has a lower propensity to violate the family-work frontier, compared to younger adults (21 to 39 years).

It was also found that the factors predicting technical stress at work have a significant relationship with the violation of the work-family border. Thus, it appears that the higher the values of the factors linked to the forecast, the greater the probability of a border violation. Other predictive factors, such as weekly working hours, the number of children, and the people they live with, were not significantly associated with work-family boundary violation in the present research.

Table 3 – Coefficients of the family-work limits violation model

Predictor	β	SE	t	p
Intercept*	2.5694	1.0829	2.373	0.018
Age group				
40 to 65 years old – 21 a 39 years old[a]	-0.9142	0.2884	-3.170	0,002
> 65 years – 21 to 39 years old	-0.2913	1.4098	-0.207	0,836
Technological overload + Technological invasion	0.1627	0.0266	6.117	< ,001
Technogical complexity + Technological insecurity	0.0905	0.0276	3,274	0.001
Inhibitors Literacy + Involvement	-0.0156	0.0389	-0,401	0,689
Credit hours				
21 to 40h – Up to 20h[b]	5535	0.3043	1.819	0,070
41 to 60h – Up to 20h[b]	6472	4192	1.544	0.124
> 60h – Up to 20h[b]	2734	1.6833	0.162	0.871
Number of children	0194	1444	-0,134	0,893
Who you live with				
With partner and/or children – Alone [c]	-0.1160	0.6067	-0.191	0.848
With parents– Alone [c]	-0.4730	1.0273	-0.460	0,646
R^2 = 0.255				

β = regression coefficients; SE, standard error; a, b, c = They represent reference levels; a, reference level for the age group = 21 to 39 years; b, reference level for the workload = up to 20h; c, reference level for those who live = alone
Source**:** Prepared by the authors (2024).

The literature states that border violation is bidirectional (Aguiar; Bastos, 2013). Thus, an analysis was carried out on the violation of boundaries between work and family.

Regarding the violation of the work-family border, the results revealed a higher R^2, reaching 0.398. This fact means that 39.8% of this variability can be explained by the dependent variables. In the analysis of this relationship (Table 4), it was found that teachers aged between 40 and 65 years presented an estimated value of -0.3782 (t = -1.241; p = 0.216) compared to those aged between 21 and 39 years, indicating a negative but not significant relationship with the violation of the work-family border.

The results for the techno-overload and techno-invasion *factors* at work were highly significant. Thus, it was found that these higher levels are strongly associated with the violation of work-family boundaries and the violation of work-family boundaries.

Table 4 – Coefficients of the work-family boundary violation model

Predictor	β	SE	t	p
Intercept*	0,1943	1.1443	0.170	0,865
Age group				
40 to 65 years old – 21 a 39 years old[a]	-0.3782	0.3048	-1.241	0.216
> 65 years – 21 to 39 years old	-0.5571	1.4898	-0.374	0.709
Technological overload + Technological invasion	0.3139	0.0281	11.168	< .001
Technogical complexity + Technological insecurity	0.0220	0.0292	0.752	0.452
Inhibitors Literacy + Involvement	-0.0410	0.0411	-0.997	0.319
Credit hours				
21 to 40h – Up to 20h[b]	0.9025	0.3216	2.806	0.005
41 to 60h – Up to 20h[b]	1.3988	0.4430	3.158	0.002
> 60h – Up to 20h[b]	3.0408	1.7788	1.709	0.088
Number of children	0.2312	0.1526	1.515	0.131
Who you live with				
With partner and/or children – Alone [c]	0.2409	0.6411	0.376	0.707
With parents– Alone [c]	-0.2574	1.0856	-0.237	0.813
R^2 = 0.398				

β = regression coefficients; SE, standard error; a, b, c = They represent reference levels; a, reference level for the age group = 21 to 39 years; b, reference level for the workload = up to 20h; c, reference level for those who live = alone.
Source: Prepared by the authors (2024).

On the other hand, Table 4 shows that the techno-complexity and techno-insecurity perceived in the work environment did not show a significant relationship with border violation and with the inhibitory factor of literacy + involvement. This result is

different from that analyzed above for the work-family relationship. This may be related to other variables that affect different aspects of the work environment in the management of work-family limits (Moreira; Silva, 2018).

This analysis, therefore, highlights the complexity of interactions between factors related to work, technology and family life. We also emphasize the importance of integrative approaches in order to understand and reduce the impact of violations of the boundaries between work and family and between family and work.

5. Final Considerations

The objective of this study was to analyze the relationship between technostress and work-family conflict, and vice versa, among Brazilian primary and secondary school teachers who work from home and are influenced by ICTs. The result was that public schools had higher levels of technostress. On the other hand, private schools showed a greater inhibiting factor for technostress, suggesting that these institutions provide more technical support and training to teachers. This support can help create a more favorable work environment. This support can help create a more supportive work environment.

Significant correlations were also found between age and perceptions of techno-complexity and technological insecurity, suggesting that older teachers tend to have more difficulties with new technologies.

In addition, regression analysis showed that technological overload and technological intrusion are associated with violating boundaries between family and work. The results suggest the need for organizational policies and practices that support teachers in coping with technological stress, especially in environments with high levels of technological stress. These interventions include ongoing training programs and measures to promote a healthy work-life balance. Implementing strategies to provide emotional and psychological support to teachers can be critical to mitigating the negative effects of technological stress and promoting a healthier and more productive work environment.

Future studies should investigate the effectiveness of specific interventions, such as training programs in time management and knowledge about the use of ICTs. In addition, it may be important to investigate how different organizational cultures influence technological stress and blurring boundaries between work and home to get a more

comprehensive picture. Longitudinal studies are needed to investigate the evolution of technological stress over time and its impact on workers' well-being, including mental health and productivity.

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