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Role of Digital Literacy in Moderating the Impact of Technostress on K-12 Teachers' Technology Adoption in China

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Abstract: *This study investigates the moderating role of digital literacy in the relationship between techno-stress and the continuance intention to use online instructional technology among K-12 teachers in China. The rapid integration of digital tools in education has led to increased levels of techno-stress, characterized by factors such as techno-insecurity, techno-uncertainty, and varying levels of ICT self-efficacy. While previous research has highlighted the negative impacts of techno-stress on teachers' technology adoption, this study explores how digital literacy may buffer these adverse effects. Utilizing a quantitative approach, data were collected from a representative sample of K-12 teachers through structured questionnaires. The findings reveal that digital literacy significantly moderates the relationship between techno-stress factors and continuance intention, suggesting that higher levels of digital literacy can mitigate the negative impacts of techno-stress, thereby promoting sustained technology use. These results underscore the importance of enhancing digital literacy among teachers to ensure effective and lasting integration of online instructional technologies in educational settings.*

Keywords: Techno-stress, Digital Literacy, Technology Adoption, K-12 Education, China

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1. Introduction

The rapid integration of online instructional technologies in educational settings has fundamentally transformed teaching and learning processes across the globe. This technological shift, while providing numerous opportunities for enhanced educational practices, has also introduced significant challenges, particularly in terms of the stress associated with technology use, commonly referred to as techno-stress. Techno-stress is characterized by the strain experienced by individuals due to their inability to cope with new technologies in a healthy manner (Rohwer et al., 2022). In educational environments, this phenomenon can significantly influence teachers' attitudes and behaviors towards technology, impacting their effectiveness and willingness to incorporate digital tools into their teaching.

Despite the burgeoning research on educational technology, there remains a critical gap in understanding the specific techno-stress factors—namely techno-overload, techno-invasion, and techno-complexity—that affect teachers' continuance intention to use online instructional technologies. Techno-overload occurs when the use of technology overwhelms teachers, techno-invasion refers to the encroachment of technology into personal time, and techno-complexity involves the challenges associated with the use of sophisticated technologies

(Mattie, 2022). These factors are crucial as they can detrimentally impact teachers' psychological well-being and their instructional performance.

Existing studies have often focused on the adoption and initial acceptance of technology among teachers, largely neglecting the sustained use or continuance intention that is vital for long-term technology integration in education. Moreover, much of the research has concentrated on quantitative assessments, providing limited insight into the underlying qualitative aspects of how and why techno-stress influences continuance intentions (Khlaif et al., 2023). This oversight suggests a need for a more nuanced exploration that not only examines the prevalence of these stress factors but also understands their interrelations and combined effects on teachers' willingness to continually engage with educational technologies.

Furthermore, the majority of techno-stress research has been conducted in business and IT contexts, with less attention given to educational settings, particularly in diverse geographical contexts like China, where cultural and institutional dynamics might influence the manifestation and impact of techno-stress differently compared to Western environments. This geographical focus is essential as the increasing push towards digital education in China necessitates a deeper understanding of local challenges faced by educators (Zhou et al., 2020).

Therefore, this study aims to fill these gaps by providing a comprehensive analysis of the impact of techno-stress on teachers' continuance intention to use online instructional technology in China. By doing so, it seeks to contribute to the broader discourse on educational technology, offering insights that can inform both theory and practice (An & Oliver, 2021). This includes developing targeted interventions to mitigate the negative effects of techno-stress and designing more supportive technological environments that foster sustained and effective use of digital tools in education.

2. Literature Review

Underlying Theory

The Technological Pedagogical Content Knowledge (TPACK) framework is pivotal in understanding the competencies required for effective integration of technology into teaching. Developed by Mishra and Koehler, TPACK extends Shulman's notion of Pedagogical Content Knowledge (PCK) by adding a technological dimension, reflecting the growing importance of technology in education (Halder, 2023). This framework provides a comprehensive view of the kinds of knowledge educators need to teach effectively using technology, encapsulating not only the content (CK) and pedagogical (PK) knowledge but also the technological knowledge (TK) necessary to effectively integrate digital tools into educational environments.

TPACK's central tenet is that the most effective teaching with technology occurs at the intersection of these three knowledge bases. Technological knowledge alone is not sufficient; educators also need a deep understanding of the pedagogical strategies that can leverage these technologies in meaningful ways and a thorough understanding of the content being taught (Herro et al., 2021). Importantly, the TPACK framework posits that understanding these intersections and interactions provides a basis for designing educational experiences that are more aligned with the capabilities provided by digital technologies.

The scholarly exploration within the TPACK framework has significantly advanced the field of educational technology. Studies have examined how teachers develop these competencies and how these developments affect their teaching practices. These inquiries have shown that

effective TPACK development often requires targeted professional development that focuses on integrating all three knowledge domains, rather than treating them as separate entities (Lehmann, 2020). This integrated approach can lead to more innovative teaching practices that make full use of technological capabilities (Loang, 2024).

Despite its widespread adoption and utility, the TPACK framework is not without criticisms and limitations. One of the major challenges in applying the TPACK framework is the difficulty in delineating clear boundaries between the three knowledge bases, as they are deeply interrelated and often overlap (Ning et al., 2024). This overlap can make it difficult to develop specific strategies for enhancing each knowledge area without impacting the others. Furthermore, there is an ongoing debate regarding the best methods to assess and evaluate TPACK competencies among educators, with some researchers questioning the effectiveness of current measurement tools in capturing the dynamic and contextual nature of these competencies.

In light of these challenges, future research needs to focus on developing clearer strategies for both assessing and enhancing TPACK among educators. Additionally, studies should consider the contextual factors that influence TPACK development, such as school culture, access to resources, and the technological infrastructure. By addressing these gaps, the educational community can better support teachers in developing the necessary skills to integrate technology into their teaching practices effectively, ultimately enhancing learning outcomes for students (Loang, 2025). The concept of techno-overload in the context of online instructional technology relates to the overwhelming sense of being burdened by excessive technological demands (Hameed et al., 2022). In educational settings, techno-overload occurs when teachers are required to adopt and integrate an array of digital tools and platforms beyond their capacity, often without adequate support or training. This phenomenon is particularly pertinent in the era of digital classrooms, where the rapid implementation of new technologies can outpace the ability of educators to adapt.

Research in this area typically shows a negative relationship between techno-overload and teachers' continuance intention to use online instructional technology (Loang, 2025). This negative influence is often mediated by factors such as stress, fatigue, and a perceived decrease in job satisfaction. When teachers feel overwhelmed by the need to constantly learn and manage new technologies, it can lead to a sense of incompetence and frustration, which are significant deterrents to the continued use of these technologies. This is crucial because teachers' attitudes towards technology significantly influence their integration of these tools into their pedagogical practices (Akram et al., 2022). Despite the growing body of literature on this topic, several research gaps remain. For instance, much of the existing research tends to focus on immediate or short-term effects of techno-overload without adequately considering the long-term impacts on teachers' professional development and well-being. Longitudinal studies are needed to understand how techno-overload affects teachers' attitudes and behaviors over extended periods, especially as they gain more experience with the technology.

Additionally, there is a lack of comprehensive models that integrate techno-overload with other psychological and organizational factors that might influence teachers' continuance intention. Factors such as individual resilience, institutional support, and the presence of a collaborative culture can potentially mitigate the negative impacts of techno-overload. Moreover, the role of personal factors, including age, technology literacy, and previous experience with digital tools, remains underexplored. These personal attributes could influence how teachers perceive and

cope with techno-overload, thereby affecting their intention to continue using the technology (Wang & Zhao, 2023).

Furthermore, the majority of studies have employed quantitative methodologies, relying predominantly on surveys to assess perceptions of techno-overload. Qualitative approaches, such as interviews or focus groups, could provide deeper insights into the subjective experiences of teachers dealing with techno-overload. These methods could uncover nuanced understandings of how teachers perceive challenges associated with technology use and what strategies they employ to manage these challenges (Ames et al., 2021). While the existing literature establishes a generally negative relationship between techno-overload and continuance intention to use online instructional technology, more nuanced research is needed to understand this relationship fully. Future studies should consider longitudinal designs, integrate broader psychological and organizational variables, explore personal factors more deeply, and employ qualitative methods to gain a richer and more comprehensive understanding of how techno-overload impacts teachers' sustained engagement with digital technologies in educational settings.

Techno-invasion refers to the way in which technology encroaches upon personal time and space, blurring the boundaries between professional and private life. This phenomenon is increasingly relevant in educational settings, where online instructional technologies facilitate constant connectivity that can extend teachers' work into hours traditionally reserved for personal time. The resultant intrusion of work-related tasks into private life due to technology use is a critical area of study within the field of educational technology (Rasool et al., 2022). The relationship between techno-invasion and continuance intention to use online instructional technology is predominantly negative. Research indicates that when teachers feel their personal life is being invaded by the demands of technology, their psychological distress increases, leading to a decrease in job satisfaction and a reduced intention to continue using such technologies. This is particularly problematic in teaching, where work-life balance is crucial to sustaining energy and enthusiasm for engaging with students. The constant availability expected due to online tools can lead to burnout, which negatively impacts the quality of teaching and the willingness to persist with the use of such technologies.

Despite these insights, there are notable gaps in the existing research. One significant limitation is the predominance of cross-sectional study designs, which capture only a snapshot of the techno-invasion experience. Longitudinal studies are necessary to truly understand how the effects of techno-invasion on continuance intention evolve over time, particularly as teachers develop strategies to manage technology's encroachment into their personal lives or as new norms and practices evolve around technology use. Additionally, much of the current research does not sufficiently differentiate between types of technological tools and their specific demands on teachers' time (Backfisch et al., 2021). Not all online instructional technologies have the same level of invasiveness. For example, asynchronous tools might be less intrusive compared to synchronous tools that require real-time interaction. Understanding these distinctions can help in designing and recommending technologies that respect work-life boundaries.

Another area that is underexplored is the role of organizational culture and support in moderating the impact of techno-invasion. Institutions that foster a culture of respect for personal time and provide clear guidelines and support for managing work-life balance might mitigate the negative impacts of techno-invasion. Additionally, individual factors such as personal boundary-setting skills, resilience, and attitudes toward technology use also likely

play significant roles in how techno-invasion affects continuance intention. These variables have not been comprehensively studied and present an opportunity for deeper investigation (Hansen et al., 2020). While the existing literature clearly outlines a negative correlation between techno-invasion and the intention to continue using online instructional technology, more nuanced research is needed to fully understand this dynamic. Future studies should look into longitudinal impacts, differentiate between types of technologies, explore the mitigating effects of institutional support and culture, and consider individual differences in coping strategies. These areas of exploration will provide a more complete picture of how techno-invasion influences teachers' professional lives and their sustained engagement with educational technologies.

Techno-complexity refers to the perceived difficulty and complexity of using technology, which can significantly influence educators' attitudes towards its adoption and sustained use. In the context of online instructional technology, techno-complexity assesses how complex and challenging teachers find the technology tools they are expected to use. This perception can play a crucial role in determining whether teachers continue to engage with these technologies or abandon them due to frustration and inefficiency. The literature generally supports a negative relationship between techno-complexity and teachers' continuance intention to use online instructional technology (Chou & Chou, 2021). This relationship is grounded in the understanding that when technologies are perceived as complex and difficult to use, they become less appealing. Teachers may feel inadequate or under-skilled, which can lead to decreased satisfaction and a higher likelihood of disengagement from the technology. This is particularly significant in education, where ease of use is crucial to ensure that teachers can focus on pedagogy rather than struggle with the technical aspects of technology.

Despite the insights provided by existing studies, there are several notable research gaps. One primary limitation is the focus on immediate or short-term perceptions of techno-complexity, often neglecting how these perceptions might change as teachers gain more experience with the technology. Longitudinal research is needed to explore how initial perceptions of techno-complexity evolve and whether continued exposure and experience with technology can mitigate its perceived complexity. Additionally, current research often treats techno-complexity as a uniform construct, failing to account for the diversity in types of technologies and their specific functionalities (Rohwer et al., 2022). Different technologies may present varying levels of complexity, and the particular features that contribute to this perception are not always clearly identified. For instance, some platforms may have user-friendly interfaces but complex back-end functionalities that are necessary for effective use, while others may be cumbersome at the initial learning stage but easier to manage once understood. Dissecting these nuances can help in designing better educational technologies that are tailored to the diverse needs of educators.

Moreover, there is a scarcity of studies that consider the contextual and environmental factors influencing perceptions of techno-complexity (Ooi et al., 2024). Factors such as institutional support, professional development opportunities, and the technology infrastructure within the school can significantly affect how teachers perceive and manage techno-complexity. Schools that provide ongoing tech support and training may see different outcomes in terms of techno-complexity perceptions compared to those that do not. while the relationship between techno-complexity and continuance intention to use online instructional technology is predominantly negative, the complexities of this relationship warrant further investigation. Future studies should consider longitudinal designs to understand changes over time, explore the specific features of technologies that contribute to complexity, and examine how different contextual

factors can influence perceptions of techno-complexity (Mattie, 2022). Addressing these gaps will not only enhance our understanding of how techno-complexity impacts educational technology use but also inform the development of more effective, user-friendly technologies that support rather than hinder educational practices.

3. Methodology

The quantitative questionnaire method employed in this study is a cornerstone of empirical research, especially pertinent in exploring the multifaceted relationships between techno-stress factors and teachers' continuance intention to use online instructional technologies. This method allows for systematic data collection from a large sample, facilitating the statistical analysis needed to understand and quantify these relationships. In designing the questionnaire, the study leverages structured questions, each formulated to precisely measure specific aspects of techno-overload, techno-invasion, techno-complexity, and continuance intention. These questions are predominantly based on Likert-scale responses, which offer participants a range of options from "strongly disagree" to "strongly agree." This scale format is chosen for its ability to capture varying degrees of agreement with the statements, providing nuanced insights into teachers' perceptions and attitudes towards technology use.

The development of the questionnaire is grounded in a rigorous review of existing scales and items used in previous research, ensuring that each item is valid and reliable for measuring the intended constructs. Before the main deployment, the questionnaire undergoes a pilot test with a smaller subset of the target population. This preliminary step is critical as it helps identify any ambiguities or misinterpretations in the questionnaire items. Feedback from the pilot test is used to refine the questions, ensuring clarity and effectiveness in capturing the relevant data. To administer the questionnaire, the study utilizes an online survey platform, which is an efficient and effective means of reaching a broad audience of K-12 teachers across various regions. This method not only ensures a higher response rate due to its convenience for participants but also facilitates quicker data collection and processing. Teachers can complete the survey at their convenience, which helps increase the participation rate and the diversity of the sample.

Once collected, the data from the questionnaires are subjected to rigorous statistical analysis. Techniques such as descriptive statistics, correlation analysis, and multiple regression analysis are employed to examine the relationships between the study variables. These analyses are instrumental in identifying the strength and direction of the relationships between techno-stress factors and continuance intention, providing empirical evidence to support or refute the study’s hypotheses. However, despite its strengths, the use of a quantitative questionnaire method also presents limitations. The reliance on self-report data can introduce biases such as social desirability bias, where respondents might answer in a manner they perceive as favorable rather than truthful. Moreover, this method captures respondents' perceptions at a single point in time, which might not accurately reflect changes in attitudes or behaviors that develop over longer periods.

Population and Sample

In this study, the population of interest comprises K-12 teachers across China who are actively engaged with online instructional technologies. This population is significant due to its diversity in terms of geographic location, educational setting, and teaching experience, reflecting a broad spectrum of encounters and interactions with educational technologies.

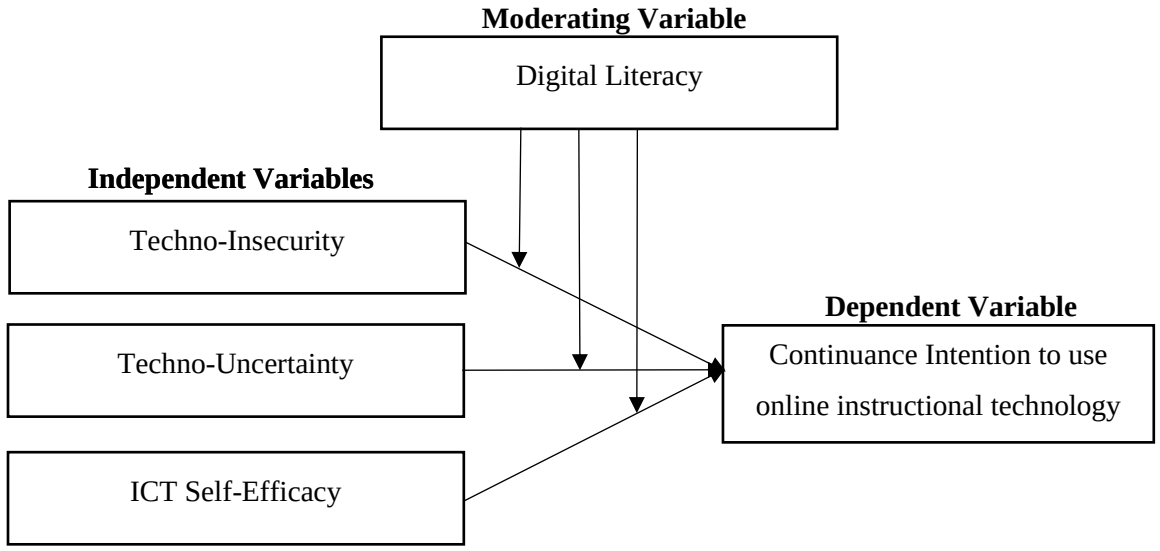
Given the vast size and varied educational landscape of China, this group presents a rich field for examining the impacts of techno-stress on teachers' technological engagement.

To effectively capture the variability within this population and ensure that the findings are generalizable, a stratified random sampling method is employed. This approach divides the population into homogeneous subgroups before sampling, which helps control for potential confounding variables such as regional educational disparities and differences in technological infrastructure. The strata are defined based on several criteria including geographic region (urban vs rural), grade level (elementary, middle, and high school), and subject taught. From each stratum, a proportionate random sample of teachers is selected, ensuring that each subgroup is adequately represented in the final sample.

For this study, the target sample size is determined using power analysis calculations to ensure sufficient statistical power to detect meaningful effects. Considering the multiple regression analyses planned, and aiming for a power of .80 at an alpha level of .05, it is estimated that a minimum of 500 participants will be necessary. This size is further justified by the intent to conduct subgroup analyses, which require a larger sample to maintain adequate power across comparisons. The data collection is conducted via an online survey, distributed through educational administration channels in various regions. This method not only enhances the reach and accessibility of the survey to a dispersed and varied group of teachers but also ensures that the data collection process is cost-effective and time-efficient. The online format is particularly apt given the focus on online instructional technologies, aligning the method of data collection with the content of the study.

Upon completion of data collection, the data undergoes rigorous preprocessing to ensure accuracy and completeness. This includes handling missing data, removing outliers, and verifying the consistency of responses. Descriptive statistics are first computed to provide an overview of the sample characteristics and preliminary insights into the data. Subsequent inferential statistical analyses, such as correlation and regression, are then performed to explore the relationships between techno-stress factors and continuance intention.

4. Conceptual Framework



The conceptual framework of this study is designed to explore the intricate relationships between various forms of techno-stress and the continuance intention of K-12 teachers in China to use online instructional technology (Khlaif et al., 2023). The framework is grounded in well-established theories from the fields of educational technology and occupational stress, and it integrates key variables that reflect both the challenges and resources available to teachers in a rapidly digitizing educational environment.

At the core of the framework are three independent variables: techno-insecurity, techno-uncertainty, and ICT self-efficacy. These variables represent different dimensions of techno-stress that can significantly influence teachers' attitudes toward and engagement with technology (Zhou et al., 2020). Techno-insecurity refers to the anxiety and fear that arise from concerns about job security or professional competence in the face of new technologies. Teachers experiencing techno-insecurity may feel threatened by the potential of technology to render their skills obsolete or by the perceived expectation that they must constantly adapt to new tools and platforms. This insecurity can create significant psychological stress, which in turn may diminish their willingness to continue using these technologies.

Techno-uncertainty captures the instability and unpredictability associated with the constant evolution of technology. In educational settings, this form of stress arises when teachers are faced with frequent updates, new tools, or shifts in technology policy that disrupt established routines and require continual adaptation (Halder, 2023). The uncertainty surrounding which technologies will be adopted long-term, or how current technologies will change, can lead to feelings of disorientation and resistance. This stressor is particularly relevant in the current era of rapid technological advancement, where the pace of change can outstrip the ability of educators to keep up, thereby impacting their continuance intention.

ICT self-efficacy represents the confidence that teachers have in their ability to effectively use information and communication technologies in their teaching practice. Unlike techno-insecurity and techno-uncertainty, which are sources of stress, ICT self-efficacy is a protective factor that can mitigate the negative impacts of techno-stress. Teachers with high ICT self-efficacy are more likely to perceive technology as a tool for enhancing their teaching rather than as a source of stress (Herro et al., 2021). This variable plays a critical role in the framework as it directly influences the likelihood of teachers continuing to engage with technology. Higher levels of ICT self-efficacy are associated with greater resilience to the challenges posed by techno-insecurity and techno-uncertainty, thereby fostering a more positive outlook on the use of online instructional technology.

The dependent variable in this study is continuance intention to use online instructional technology. Continuance intention refers to the teachers' commitment to persist in using digital tools for instruction over time, despite the challenges and stressors they may encounter. This variable is crucial for understanding the long-term sustainability of technology integration in education. A high continuance intention indicates that teachers are willing to invest in the ongoing use of technology, which is essential for the successful implementation of digital education initiatives (Lehmann, 2020). Conversely, a low continuance intention suggests that teachers may be at risk of abandoning the use of technology, which could undermine educational goals and lead to a reversion to traditional, non-digital methods. The relationship between the independent variables (techno-insecurity, techno-uncertainty, and ICT self-efficacy) and the dependent variable (continuance intention) is hypothesized to be complex and moderated by digital literacy. Digital literacy, as a moderating variable, refers to the teachers' ability to effectively navigate, evaluate, and utilize digital tools and resources. It encompasses

a range of skills, including technical proficiency, critical thinking, and the ability to integrate technology into pedagogical practices. The moderating role of digital literacy suggests that its presence can either amplify or attenuate the effects of techno-stress on continuance intention.

In the framework, digital literacy is posited to have a buffering effect, particularly in mitigating the negative impacts of techno-insecurity and techno-uncertainty. Teachers with high levels of digital literacy are likely to feel more confident and competent in their use of technology, which can reduce feelings of insecurity and uncertainty (Ning et al., 2024). As such, even in the face of rapid technological change or perceived threats to professional competence, these teachers may maintain a strong intention to continue using online instructional tools. On the other hand, teachers with low digital literacy may find these stressors overwhelming, leading to a diminished intention to engage with technology.

5. Conclusion

The conclusion of this study sheds light on the significant impact of techno-stress factors—techno-overload, techno-invasion, and techno-complexity—on teachers' continuance intention to use online instructional technology. These findings not only enrich the existing body of knowledge in educational technology but also provide critical insights for educational practitioners and policymakers aiming to foster sustainable technology use in teaching environments. Central to the study's findings is the clear negative influence of techno-stress factors on teachers' willingness to continue using technology. Techno-overload, where teachers feel overwhelmed by the excessive demands of technology, techno-invasion, where technology encroaches upon personal time, and techno-complexity, which entails the perceived difficulty of using technology, all significantly deter teachers' continuance intentions. This negative relationship underscores the importance of addressing techno-stress proactively to prevent attrition in technology use, which can undermine the potential benefits of educational technology.

The study also highlights the mediating role of perceived usefulness and ease of use in the relationship between techno-stress factors and continuance intention. These findings suggest that even when techno-stress is high, if the technology is perceived as useful and easy to use, teachers might be more inclined to continue its use. This revelation points to the practical need for educational technology developers to prioritize user-friendly design and for educational institutions to provide adequate training that emphasizes the practical benefits and functionalities of technology. Moreover, the results regarding the moderation effects of institutional support indicate that the negative impacts of techno-stress can be mitigated in environments that provide robust technological and emotional support to teachers. Schools and educational institutions play a pivotal role in shaping the technological landscape and can significantly influence teacher attitudes and behaviors towards technology use through supportive policies, professional development opportunities, and resources that ease technology adoption and integration.

Pedagogical Implication

The pedagogical implications of this study are profound, offering valuable insights for educators, administrators, and policy makers involved in the integration of technology into educational settings. The findings highlight the need for a nuanced understanding of how techno-stress factors—techno-overload, techno-invasion, and techno-complexity—affect teachers' willingness to continue using online instructional technologies. These insights are essential for fostering effective and sustainable teaching practices that leverage technology to

enhance learning outcomes (Hameed et al., 2022). Firstly, the negative impact of techno-overload on teachers' continuance intention underscores the importance of balanced technology integration. Educational leaders should consider the workload associated with new technologies and strive to integrate these tools in ways that do not overwhelm teachers. This might involve providing adequate training and resources, ensuring that teachers are well-equipped to use these technologies without excessive strain. Additionally, it might be beneficial to incorporate feedback mechanisms where teachers can report their experiences and challenges with technology, enabling continuous refinement and adjustment of technology policies and practices.

Secondly, the issue of techno-invasion highlights the need for clear boundaries between work and personal life. Schools should develop and enforce policies that protect teachers' personal time from the encroachment of technology. This could include guidelines on communication practices, such as setting expectations for response times outside of school hours and limiting the scheduling of online activities during evenings or weekends. Such policies not only help prevent burnout but also support teachers in maintaining a healthy work-life balance, which is crucial for long-term job satisfaction and effectiveness (Akram et al., 2022). Furthermore, the challenge of techno-complexity calls for targeted professional development that focuses on building technological proficiency in a supportive environment. Professional development programs should be designed to meet teachers at their individual levels of technological competence and gradually build their skills. These programs should also be iterative, allowing for ongoing learning and adaptation to new technologies. By reducing the perceived complexity of online instructional tools, schools can enhance teachers' confidence and competence in using these technologies, thereby increasing their willingness to continue their use.

Moreover, the study's findings suggest that institutional support plays a crucial role in mediating the effects of techno-stress. Schools and educational institutions should consider establishing dedicated support systems, such as technical support teams and instructional technology specialists, who can assist teachers in navigating technological challenges. By strengthening the support infrastructure, schools can alleviate some of the stress associated with technology use and create a more positive and encouraging environment for teachers (Ames et al., 2021). The pedagogical implications of this study are clear: to effectively integrate technology into educational practices, it is essential to address the techno-stress factors that can hinder its use. By implementing thoughtful policies, providing supportive professional development, and ensuring robust institutional support, educational leaders can help mitigate the negative impacts of techno-stress and promote a healthier, more sustainable use of technology in teaching. These measures will not only enhance teachers' job satisfaction and retention but also improve the quality of education that students receive, ultimately contributing to better educational outcomes.

Limitations and Recommendations

This study provides insightful contributions to the understanding of techno-stress among teachers using online instructional technologies. However, like all research, it is subject to certain limitations that should be addressed in future investigations to deepen and broaden the understanding of this important area. One significant limitation of the current study is its reliance on cross-sectional data, which captures only a snapshot of the teachers' perceptions at a single point in time. This approach limits the ability to discern causal relationships and track how these perceptions evolve as teachers become more experienced with the technology or as the technology itself evolves. Future research could benefit from adopting a longitudinal design, following teachers over an extended period to observe how their continuance intentions

and experiences with techno-stress change over time. This would provide a more dynamic view of the factors influencing teachers' sustained use of technology and the long-term effects of techno-stress.

Another limitation is the study's dependence on self-reported data, which can introduce biases such as social desirability or response bias, where participants might answer in ways they believe are expected or socially acceptable. To counteract this, future studies might incorporate more objective measures of technology use and stress levels, such as log data from educational platforms to accurately track usage patterns, or physiological measures of stress. Combining qualitative data through interviews or focus groups could also enrich the quantitative findings, offering deeper insights into the personal experiences and contexts that influence techno-stress among teachers. The scope of the study, focused primarily on K-12 teachers in a specific geographical and cultural context, may also limit the generalizability of the findings. Techno-stress and its impacts are likely influenced by a variety of cultural, institutional, and socio-economic factors that can vary significantly across different regions and educational levels. Future research should consider expanding the demographic and geographic diversity of the sample to include teachers from different educational levels, such as higher education, and from various cultural backgrounds. This would enhance the external validity of the study, allowing for a more comprehensive understanding of how different contexts affect the relationship between techno-stress and technology continuance intentions.

Furthermore, the study primarily concentrates on negative aspects of technology use without equally exploring potential positive impacts that technology can have on teaching and learning. Future studies should adopt a more balanced approach by examining both the benefits and challenges of technology use in education. Understanding the positive aspects of technology use could help in designing interventions that not only mitigate techno-stress but also enhance the effectiveness and satisfaction of technology integration in educational settings. While this study makes important contributions to the field of educational technology by highlighting the impact of techno-stress on teachers' continuance intentions, addressing these limitations in future research could significantly advance our understanding of how to better support teachers in navigating the challenges of digital education. By exploring these areas, future studies can contribute to more effective and sustainable integration of technology in education, ultimately improving teaching practices and learning outcomes.

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