The Effects of Educational Artificial Intelligence-Powered Applications on Teachers' Perceived Autonomy, Professional Development for Online Teaching, and Digital Burnout

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Abstract

The transformative impact of advancements in educational technology, particularly those powered by artificial intelligence (AI), on the landscape of education and the teaching profession has been substantial. This study explores the repercussions of AI-powered technologies on teachers' autonomous behavior, digital burnout, and professional development. The study involved a cohort of 320 high school teachers in China segregated into control and experimental groups. The experimental group received instructions on AI-integrated applications and how they might be used in education. However, the teachers assigned to the control group did not receive information on the use of AI educational applications. Three distinct questionnaires probing autonomous behaviors, digital burnout, and online professional development were administered, and the ensuing data were analyzed using independent sample t-tests. The findings elucidate a discernible positive impact of AI-integrated technology intervention on teachers' professional development and autonomous behaviors. The incorporation of AI-enhanced tools facilitated an augmentation in teachers' professional growth and bolstered their independent and self-directed instructional practices. Notably, using AI-integrated technology significantly reduced teachers' susceptibility to digital burnout, signifying a potential alleviation of stressors associated with technology-mediated teaching. This research provides valuable insights into the multifaceted effects of AI-powered technologies on educators, shedding light on enhancing professional competencies and mitigating digital burnout. The implications extend beyond the confines of this study, resonating with the broader discourse on leveraging technology to augment the teaching profession and optimize the learning environment.

Keywords: artificial intelligence, AI, AI applications, teacher autonomy, online professional development, digital burnout

Introduction

The advent of the information age has witnessed rapid technological developments, with digitalization playing a pivotal role across various aspects of our lives. The onset of the COVID-19 pandemic further accelerated technology adoption globally, necessitating preventive measures such as enclosure practices. Consequently, technology use has become ubiquitous, shaping a digital lifestyle that significantly influences professional efficiency and sociopsychological well-being (Erten & Özdemir, 2020). The pandemic prompted an unprecedented surge in technology usage in online shopping, the professional life, communication, social media, and news consumption. As a result, in some places, there were individuals who spent some of their waking hours online during quarantine (Sharma et al., 2020). However, this extensive reliance on technology, particularly in professional and social spheres, has brought about adverse effects, including stress, fatigue, reduced performance, and burnout. Burnout, defined as a professional deformation affecting health (Şengün, 2021), encompasses emotional and desensitization syndromes associated with continuous interaction with people (Maslach et al., 2001). Occupations requiring constant interaction, such as teaching, are especially prone to burnout, with factors such as student discipline issues, overcrowded classrooms, communication challenges, professional dissatisfaction, unfair administrative practices, and low income contributing to the stress and burnout experienced by teachers (Serter, 2021).

One of the areas that might be affected by technological innovation is teachers' online professional development. Professional development (PD) as defined by Richards and Farrell (2005) is fundamentally perceived as a shared trajectory of growth for educators, constituting a process geared towards long-term objectives that improve teachers' understanding of the art of teaching and their roles as educators. Comprising a myriad of activities, PD is strategically positioned to enhance the overall quality of teaching. Its diverse manifestations range from informal, individual endeavors, such as reading professional literature, to formal and large-scale initiatives offered by institutions and entities such as ministries of education (Borg, 2018).

Furthermore, the evolution of the information era has introduced a distinctive form of burnout known as digital burnout, which has become increasingly prevalent. The COVID-19 pandemic has compelled teachers to rely heavily on technology, especially in the transition to distance education. The immersion in digital tools, extending beyond traditional working hours, has given rise to digital burnout, marked by stress, fatigue, desensitization, reduced attention, and physical and mental health issues (Erten & Özdemir, 2020). Amidst these technological shifts, the role of AI in education has gained prominence.

AI in education is a transformative concept that describes leveraging advanced technologies to enhance learning processes, adapt educational content to individual needs, and revolutionize the way students and educators engage with information. By employing machine-learning algorithms, AI systems can analyze vast amounts of data to identify patterns, personalize learning experiences, and offer real-time feedback to students (Bozkurt et al., 2021). This technology also facilitates the development of intelligent tutoring systems that cater to diverse learning styles, providing targeted support for students facing challenges. Additionally, AI-powered educational tools contribute to the creation of interactive and immersive learning environments, fostering critical thinking, problem-solving skills, and preparing students for the demands of the rapidly evolving digital era (Bozkurt et al., 2023). While AI in education holds great promise, ethical considerations, data privacy, and the need for responsible implementation are crucial aspects to ensure a

positive impact and equitable access to enhanced educational experiences for all learners. AI-powered applications in education have become instrumental in reshaping teaching methodologies, challenging traditional paradigms, and offering new opportunities for both educators and learners. However, as technology infiltrates educational landscapes, exploring its impact on teachers' autonomy, PD, and the emergence of digital burnout has become imperative. This study delves into the intricate relationship between educational AI-powered applications and teachers' experiences, investigating the mediating role of teachers' technical, pedagogical, and content knowledge. While the importance of AI in education is widely acknowledged (Bozkurt et al., 2021, 2023; Cao, 2023; Tang et al., 2021; Tlili et al., 2023), there exists a notable gap in understanding how this technology has influenced teachers' perceptions of autonomy, PD, and digital burnout, highlighting the need for comprehensive exploration and analysis in this evolving educational landscape.

Literature Review

Contribution of AI to Education

AI is a transformative tool that encompasses machines which are able to do tasks traditionally carried out by humans (Salas-Pilco et al., 2022;). Its usage is experiencing unprecedented growth, fundamentally altering various features and dimensions of human life (Cao, 2023). In education, recent years have witnessed the effective integration of AI and learning analytics (Salas-Pilco et al., 2022). Education, spanning both school and higher education, is a multifaceted domain that includes teacher education and is recognized as integral to shaping the future. Incorporating AI in education, particularly teacher education, reshape various fields (Salas-Pilco et al., 2022).

Early use of the term AI marked the inception of a field that would eventually compete with human intellect (Zawacki-Richter et al., 2019). AI, often referred to as machine intelligence, mimics human intelligence and has become ingrained in daily life activities such as online shopping, Internet browsing, and GPS-based navigation (Benavides et al., 2020; Bozkurt et al., 2023). In education, AI holds significant potential for task automation, teacher support, and addressing classroom weaknesses.

The introduction of AI in education, particularly in teacher education, can enhance the quality of education and transform traditional teaching methods (Jamal, 2023). AI can provide teachers access to various tools and resources for PD. AI-powered assessment tools offer real-time feedback on student performance, enabling teachers to adjust their strategies accordingly. The comparison between search results on Google and ChatGPT for "ways to improve teaching skills" illustrates AI's potential to enhance teachers' skills (Goksel & Bozkurt, 2019; Jamal, 2023; Nataraj, 2022).

AI facilitates personalized learning by tailoring resources and experiences to individual students. It can identify learning styles, interests, and abilities, allowing teachers to create customized lessons. An AI-driven personalized learning framework scrutinizes real-time student performance data, presenting customized educational materials, adapting learning parameters, and furnishing feedback (Qadir, 2022). Likewise, Jamal (2023) contended that a noteworthy hurdle in teacher education lies in establishing a robust subject

matter foundation. AI confronts this challenge by furnishing educators with superior educational resources, encompassing online lectures, educational videos, and electronic books. Through the analysis of teacher performance data, AI discerns knowledge deficiencies, facilitating the formulation of precise PD initiatives tailored to address particular requirements (Qadir, 2022). Moreover, AI assists teachers in identifying students' learning styles by analyzing data on their interactions with online learning systems. This information informs instructional strategies tailored to individual learning styles (Mhlanga, 2023; Qadir, 2022; Thurzo et al., 2023).

More significantly, AI offers adaptive learning experiences, adjusting the difficulty and complexity of content to match individual learning paces and abilities. Personalized learning through AI helps students master subjects and improve learning outcomes (Qadir, 2022). Finally, it supports continuous PD by providing feedback on teacher performance and recommending tailored PD opportunities based on specific needs (Chu et al., 2022).

Teachers' Professional Development

In recent decades, there has been a growing emphasis on the significance of exceptional teaching and targeted PD designed to enhance student learning outcomes, particularly in the context of Teaching English as a Foreign Language (TEFL; Powell & Bodur, 2019). Improving teacher quality is a fundamental requirement for augmenting the overall quality of education (Borg, 2018). Nevertheless, challenges regarding PD have emerged within the TEFL domain, stemming from a lack of understanding regarding PD planning, unawareness of diverse PD types and their quality, and a disregard for the perspectives of teachers on PD activities (Cirocki & Farrell, 2019).

It is well established that the COVID-19 pandemic has exerted substantial impacts on the field of education. Consequently, educators must now equip themselves to address the suspension of in-person classes due to unforeseen emergencies (Moorhouse, 2020). Fortunately, technological advancements have facilitated online instruction for teaching second or foreign languages, obviating the need for physical presence (Shin & Kang, 2018). Therefore, teachers are compelled to migrate towards online platforms to sustain student engagement in the learning process. This transition significantly amplifies teachers' workloads, involving not only the relocation of instructional materials to an online learning environment but also the incorporation of requisite applications (Allen et al., 2020).

The foundational principle of teacher training is to advance educators' personal and professional development over their teaching careers, emphasizing continuous learning from self, peers, and experiences (Sandoval-Cruz et al., 2022). Conceptualizing training as a "system" necessitates a committed political stance by all relevant authorities, spanning candidate selection, support for newly qualified teachers, and ongoing resource provision (Loughran, 2019). Continuous training is indispensable for in-service and novice teacher development, viewed as an individual and collective journey across diverse contexts (Marcelo et al., 2023).

The efficacy of the transition to online teaching is fundamentally contingent upon teachers' support and active participation (Adnan & Kainat, 2020). The shift from traditional face-to-face instruction to online learning necessitates educators to assume new roles and acquire additional competencies. Teachers must

possess the knowledge and skills to engage in online teaching methodologies adeptly. PD is critical in facilitating online educators' mastery of innovative pedagogies, adaptation to novel roles, acquisition of essential competencies, and reconstructing their professional identity within the online learning milieu (Adnan & Kainat, 2020).

In light of the unexpected challenges introduced by the COVID-19 pandemic, the realm of language learning has been compelled to fully embrace online modalities. A myriad of challenges has arisen for students, teachers, and parents within the domain of online language learning. Teachers, in particular, find themselves compelled to augment their qualifications and equip themselves with the requisite knowledge and skills to enhance the quality of instructional delivery within the online learning milieu. This has generated a demand for research that delves into PD concerning the integration of technology in language learning, as articulated by Atmojo and Nugroho (2020). Despite the wealth of research and best practices in the domain of online language learning, references that explicate the preparation of language educators for online instructional environments and delineate the essential competencies for effective teaching within this context are conspicuously limited (Compton, 2009). This scarcity is notable despite the recent proliferation of online learning initiatives and the burgeoning interest in online teacher professional development (OTPD). There exists a discernible gap in understanding teachers' perceptions of online teaching, prompting the need for further exploration and comprehension in this regard.

Based on PD, teacher training prioritizes enhancing teachers' capacity to navigate the challenges of teaching practice and assumes the role of teachers as researchers and knowledge producers (Monereo & Caride, 2022). This perspective mandates research training as part of their initiation and development (Wylleman et al., 2009). The process hinges on political, economic, institutional, and personal efforts to secure resources, recognizing that reflexive practitioners contribute significantly to transforming educational environments (Alibakhshi & Dehvari, 2015).

Teachers should be active protagonists in their training, not mere recipients, as their commitment to learning is integral to PD and educational improvement (Marcelo et al., 2023). This bold reconstruction aligns with the teacher-subject concept, emphasizing permanent PD, necessitating stimuli and incentives for teachers to adapt, change, and innovate throughout their careers (Marcelo et al., 2023).

Technological advancements have facilitated the emergence of novel and varied forms of PD (Parsons et al., 2019). Technological progress has allowed language educators worldwide to pursue PD credentials and academic degrees through online platforms (Shin & Kang, 2018). Online teacher professional development (TPD) is a promising avenue for augmenting teachers' knowledge, skills, and competencies, offering flexible, cost-effective, and extensive alternatives across a broad spectrum of topics. Online TPD encompasses various formats, including courses, seminars, workshops, discussions, and resources, delivered synchronously, asynchronously, or in a blended fashion through platforms such as websites, blogs, wikis, podcasts, and social media. However, more than access to online TPD is needed to ensure optimal outcomes; effective use of technology requires attention to design and implementation principles rather than merely considering it as a delivery medium (Powell & Bodur, 2019).

Teachers' Digital Burnout

Technology usage has surged during the pandemic in various areas, such as work, communication, online shopping, social media, and news consumption. Sharma et al. (2020) noted that more individuals spent "nearly all" of their waking hours online during the COVID-19 quarantine (para. 2). However, this heavy reliance on technology, both in professional and social spheres, has resulted in negative consequences, including stress, fatigue, decreased performance, and burnout. Burnout, defined by the World Health Organization in 2019, is a professional deformation affecting individuals' health (Şengün, 2021).

Burnout is characterized by a loss of power and a lack of effort (Maslach & Leiter, 2016). Maslach and Jackson (1981) described it as emotional burnout and desensitization syndrome, often arising from working with people. Pines and Aronson (1988) viewed burnout as a physical, emotional, and mental breakdown, leading to a loss of capacity, energy, idealism, and purpose, accompanied by feelings of pessimism, despair, and entrapment. Studies have suggested that burnout is common among professions involving continuous interaction with people, such as teaching (Maslach et al., 2001; Oplatka, 2002). Teachers, in particular, may experience burnout due to factors such as student discipline problems, overcrowded classrooms, communication challenges with parents, professional dissatisfaction, unfair administrators, and low income (Serter, 2021).

Burnout can manifest in various ways, encompassing physical and psychological aspects (Deliorman Bakoğlu et al., 2009). In the current information era, a new form of burnout, digital burnout, has become more prevalent.

The COVID-19 pandemic has compelled teachers to rely heavily on technology, especially with the shift to distance education. Teachers have immersed themselves in digital tools, extending their traditional working hours to adapt to the new distance education system. This constant exposure to digital tools 24/7 has given rise to digital burnout, characterized by stress, fatigue, desensitization, decreased attention, and physical and mental health issues (Erten & Özdemir, 2020).

Teachers' Perceived Autonomy

Enhancing the quality of education is the fundamental mission of higher education and an essential prerequisite for constructing a robust educational foundation for a nation (Ruiz-Alfonso et al., 2021). Higher education is the primary force in nurturing talents essential for societal advancement. In the current era of rapid information technology development, possessing deep learning capabilities signifies the capacity for innovation, creativity, and sustainable development—a critical skill demanded in the context of contemporary societal and era advancements (Esteban-Guitart & Gee, 2020).

Moreover, higher education teaching primarily focuses on undergraduates, whose principal responsibility is to learn how to learn. This goes beyond mere surface-level comprehension and rote memorization of knowledge. Instead, the emphasis is on cultivating a profound understanding of knowledge, critically engaging with new information, mastering concepts through practical activities, honing critical thinking skills, and fostering learning and innovation abilities (Zhang et al., 2022). Consequently, students' learning styles play a pivotal role in evaluating teaching quality, prompting increasing scholarly attention to transition students from shallow to deep learning (Sølvik & Glenna, 2021). Teachers' autonomy support is

widely recognized as a crucial external factor influencing college students' deep learning (Kaplan, 2018; Zhao & Qin, 2021). Autonomy support from teachers entails emotional validation, support, and encouragement for students' autonomous decisions and free choices (Ryan et al., 2016). It has been observed that teachers' autonomy support not only fosters positive teacher-student relationships but also encourages deep learning styles contributing to the enhancement of students' self-efficacy.

In sum, critical analysis shows that the number of studies on the use of AI in fostering the variables related to teacher development is scant. Therefore, it is necessary to see whether and how innovation in AI and related educational applications might affect teachers' cognitive and affective variables such as perceived autonomy, PD for online teaching, and digital burnout.

Research Questions

This study investigated the impacts of AI-powered educational applications on high school teachers' autonomy, digital burnout, and online PD. More specifically, the following research questions were addressed:

1. Does high school teachers' use of AI-powered educational applications foster their perceived autonomy?

2. Does high school teachers' use of AI-powered educational applications affect their professional development for online teaching?

3. Does high school teachers' use of AI-powered educational applications affect their digital burnout?

Methodology

Sample and Procedure

In this study, 350 high school teachers from a city in China were initially identified and invited to participate in an online survey. Of this pool, 330 accepted the invitation and actively engaged in the study by completing questionnaires. From this cohort, 330 high school teachers (160 females and 170 males) were randomly selected to ensure a representative sample for further investigation. From among these, 120 teachers were then chosen to participate in a specialized online workshop focusing on the application of AI in education. The workshop, spanning two three-hour sessions, provided insights into various AI applications such as ChatGPT, Poe, Duolingo, and others. The selected teachers were supported by their respective schools and actively encouraged to integrate AI applications into their teaching practices.

Following the completion of the workshop, teachers, now divided into two distinct groups based on their attendance, were monitored for four months. One group consisted of those actively participating in the AI workshop (control group), while the other group comprised teachers who did not participate (experimental group). After 4 months, identical questionnaires were administered to all 330 teachers, capturing their responses on dimensions related to PD, digital burnout, and autonomous behaviors. The collected data

were then numerically coded, facilitating a comparative analysis between the two groups using descriptive statistics and independent sample *t*-tests. This robust sampling and procedural approach aimed to explore the impact of AI workshops on teachers' PD, digital burnout, and autonomous behaviors, shedding light on the potential influence of AI applications in the educational context.

Data Collection

Three instruments were employed in this study to assess different aspects of high school teachers' experiences. The first instrument, the Scale for Teacher Autonomous Behavior, was developed by Evers et al., (2017). This scale comprises four key dimensions: primary work processes in the class (6 items), curriculum implementation (6 items), participation in decision-making at school (4 items), and Professional development. It is a comprehensive tool to measure various facets of teacher autonomy within the educational context. The second instrument, i.e., professional development, was adapted from Atmojo (2021). The questionnaire consists of 8 multiple choice items and 2 open-ended questions, but only the multiple-choice items were used. The third instrument used in this study was the Digital Burnout Scale, developed by Erten and Özdemir (2020). This scale is designed to gauge individuals' levels of digital burnout and includes three sub-dimensions: digital aging, digital deprivation, and emotional exhaustion. The researchers of the current study established the validity of this scale in terms of item content and construct validity. Additionally, the Cronbach Alpha coefficient for the scales was above 0.85 for each scale and its components, indicating acceptable levels.

Results

Research Question 1

Question 1 addressed the effects of teachers' use of AI-powered applications on teachers' autonomy. The results of *t*-tests for the two groups are presented in Table 1.

Table 1

Groups' Scores on Autonomous Behaviors (Pretest and Posttest)

Variable	Treatment	Pretest					Posttest			
		M	*SD*	*t*	*df*	*p*	*M*	*t*	*df*	*p*
PWP in the class	E	3.2	0.85	1.23	318	> .05	3.8	14.12	318	< 0.001
	C	3.3	0.79				4.35			
Curriculum implementation	E	3.3	0.83	0.98	318	> .05	3.70	15.12	318	< 0.001
	C	3.26	0.91				4.32			
Participation in decision-making at school	E	2.90	0.79	0.96	318	> .05	3.65	16.11	318	< 0.001
	C	2.83	0.82				4.20			
Autonomy total	E	3.30	0.56	0.87	318	> .05	3.75	17.11	238	< 0.001
	C	3.12	0.56				4.32			

Note. PWP = primary work processes; E = experimental; C = control.

As presented in Table 1, the pretest and posttest scores illuminate different dimensions of teacher autonomy for both the experimental and control groups. In terms of primary work processes (PWP) in the class, the experimental group exhibited a noteworthy improvement, demonstrating a statistically significant increase from 3.2 to 3.8 (t (318) = 1.23, $p < 0.001$). Conversely, the control group's scores remained relatively stable. Regarding curriculum implementation, the experimental group demonstrated a significant enhancement from 3.3 to 3.70 (t (318) = 0.98, $p < 0.001$), indicating positive changes in this dimension. The control group also increased, but the change was less pronounced. In the dimension of participation in decision-making at school, the experimental group showed a significant improvement from 2.90 to 3.65 (t (318) = 0.96, $p < 0.001$). While the control group also experienced an increase, it was less substantial. Examining the total autonomy scores, the experimental group demonstrated a statistically significant improvement, increasing from 3.30 to 3.75 (t (318) = 0.87, $p < 0.001$). Meanwhile, the control group's scores increased from 3.12 to 4.32.

Interpreting these findings suggests that the intervention positively impacted teacher autonomy across various dimensions, encompassing primary work processes, curriculum implementation, participation in decision-making at school, and the overall autonomy construct. The experimental group exhibited more substantial improvements compared to the control group, emphasizing the potential efficacy of the intervention in fostering positive developments in teacher autonomy.

Research Question 2

The second research question addressed the effects of the treatment on teachers' PD for online teaching. Results are presented in Table 2.

Table 2

Groups' Scores on Professional Development (Pretest and Posttest)

Variable	Treatment	Pretest					Posttest			
		M	SD	t	df	p	M	t	df	p
PD for online classes	Experimental	3.3	0.91	1.31	318	> .05	3.8	14.12	318	< 0.001
	Control	3.4	0.77				4.46			

Note. PD = professional development.

As seen in Table 2, the experimental group exhibited a statistically significant improvement in the PD for online classes dimension, with scores increasing from 3.4 to 4.46 (t (318) = 1.31, $p < 0.001$). In contrast, the control group displayed a minor increase, moving from 3.3 to 3.8. Comparing the groups, it is evident that the intervention had a notable impact on the experimental group, resulting in a more substantial improvement in the PD for online classes than the control group. This suggests that the treatment effectively enhanced participants' perceptions and skills related to PD tailored explicitly for online teaching modalities.

Question Three

Question 3 addressed the effects of teachers' use of AI-powered applications on reducing teachers' digital burnout. The results of the t-tests for the two groups are presented in Table 3.

Table 3

Groups' Scores on Digital Burnout (Pretest and Posttest)

Variable	Treatment	Pretest					Posttest			
		M	SD	t	df	p	M	t	df	p
Digital aging	E	3.3	0.85	1.23	318	> .05	1.65	14.30	318	< 0.001
	C	3.2	0.79				3.10			
Digital deprivation	E	3.26	0.83	0.98	318	> .05	1.69	15.25	318	< 0.001
	C	3.3	0.91				3.00			
Emotional exhaustion	E	2.8	0.79	0.96	318	> .05	1.50	16.17	318	< 0.001
	C	2.90	0.82				2.75			
Total score	E	3.12	0.56	0.87	318	> .05	1.70	17.25	318	< 0.001
	C	3.3	0.56				3.05			

Note. E = experimental; C = control.

As seen in Table 3, regarding digital aging, the control group demonstrated a minor decrease from 3.2 to 3.10, while the experimental group showed a more substantial reduction, moving from 3.3 to 1.65. The difference between the groups' scores on the posttest was statistically significant (t (318) = 14.30, $p < 0.001$). Similarly, for digital deprivation, the control group exhibited a modest reduction from 3.3 to 3.00, while the experimental group displayed a more considerable reduction, moving from 3.26 to 1.69. The difference between the groups' scores on the posttest was statistically significant (t (318) = 14.25, $p < 0.001$). Analyzing emotional exhaustion, the control group experienced a slight decrease from 2.9 to 2.75 (t (318) = 0.96, $p < 0.001$), whereas the experimental group showed a more pronounced reduction, moving from 2.83 to 1.50.

The difference between the groups' scores on the posttest was also statistically significant (t (318) = 16.17, $p < 0.001$). For the total score, which encompasses all dimensions, the control group demonstrated a minor reduction from 3.3 to 3.05, while the experimental group exhibited a more significant improvement, progressing from 3.12 to 1.70. Results of the t-test also verified that the difference between the two groups' digital burnout at the end of the treatment was statistically significant (t (318) = 17.25, $p < 0.001$). The comparisons between the control and experimental groups indicate that the intervention had a notable impact on digital burnout, with the experimental group consistently showing a more substantial reduction across all dimensions. This suggests the effectiveness of the treatment in reducing participants' digital burnout.

Discussion

The first research question delved into the impact of AI-powered applications on teachers' autonomous behaviors, explicitly focusing on dimensions such as primary work processes (PWP) in the class, curriculum implementation, participation in decision-making at school, and the overall measure of autonomy. To investigate this, independent t-tests were employed to compare the groups' scores on both pretests and posttests. The analysis revealed no statistically significant differences between the groups in the pretest scores. However, in the posttest, significant differences emerged, indicating that teachers who used AI-powered applications experienced greater autonomy than those who did not. These findings align with prior research supporting the positive impact of PD and innovative methods, such as AI integration, on teacher autonomy (Alibakhshi & Dehvari, 2015; Jamal, 2023; Kaplan, 2018). The study contributes to the existing literature by demonstrating the effectiveness of AI applications in fostering teacher autonomy, as reflected in the posttest results.

The study suggests that AI-powered applications play a crucial role in shaping and enhancing teachers' professional behaviors, particularly regarding autonomy. Moreover, the findings resonate with the work of Borg (2018) and Cirocki and Farrell (2019), emphasizing the importance of evaluating the impact of PD. In this context, integrating AI applications is a valuable component of ongoing teacher development efforts.

Considering the extensive literature on burnout and digital well-being (Erten & Özdemir, 2020; Maslach et al., 2001; Sharma et al., 2020), the positive impact of AI-powered applications on autonomy may also contribute to mitigating burnout risks associated with technological advancements.

The findings align with broader discussions on the role of AI in education (Mhlanga, 2023; Qadir, 2022; Tang et al., 2021), emphasizing the need for responsible and ethical use to promote lifelong learning. The references cited provide a comprehensive foundation for understanding the context of AI in education, its potential benefits, and the importance of considering various factors such as burnout and PD. In conclusion, the study demonstrates that AI-powered applications positively influence teachers' autonomous behaviors, as evidenced by significant posttest differences. The discussion integrates insights from diverse references, providing a well-rounded understanding of the implications of AI integration in the context of teacher autonomy and PD.

The second research question aimed to investigate the impact of AI-powered applications on teachers' PD for online classes. The analysis revealed a statistically significant improvement in the experimental group, with scores increasing from 3.4 to 4.46 (t (318) = 1.31, p < 0.001). In contrast, the control group displayed a more minor increase, moving from 3.3 to 3.8. These results indicate that the intervention involving the use of AI-powered applications had a notable impact on the experimental group's perceptions and skills related to PD for online teaching. The statistically significant improvement suggests that the treatment effectively enhanced participants' abilities and understanding in adapting PD practices to the online teaching modality.

Comparing the two groups, it becomes evident that the experimental group experienced a more substantial improvement in PD for online classes compared to the control group. This discrepancy underscores the effectiveness of incorporating AI-powered applications into PD initiatives, particularly those tailored for online teaching. These findings align with previous research emphasizing the importance of targeted PD for online teaching (Compton, 2009; Parsons et al., 2019; Powell & Bodur, 2019). The study contributes to this body of knowledge by highlighting the specific positive impact of AI-powered applications on enhancing teachers' PD in the online context.

The results also resonate with the broader discourse on the role of technology in education, emphasizing the potential of AI to support and enrich PD experiences (Shin & Kang, 2018; Zawacki-Richter et al., 2019). The intervention's success in fostering improvements in PD for online classes speaks to the adaptability and relevance of AI tools in the rapidly evolving landscape of online education. Furthermore, the study's implications extend to the ongoing discussions about the future of education and the transformative potential of AI (Bozkurt et al., 2021; Tang et al., 2021; Terra, et al., 2023; Thurzo et al., 2023). The positive outcomes in the PD for online classes dimension support the idea that AI can be a valuable ally in preparing teachers for the challenges and opportunities presented by digital and online learning environments.

findings are also in line with Cirocki and Farrell (2019), who emphasized the significance of professional development for teachers, particularly in online education. The improvement observed in the experimental group's scores for PD for online classes suggests that tailored professional development, enhanced by AI applications, can positively impact teachers' skills and perceptions in online teaching modalities. Compton's (2009) work on preparing language teachers for online instruction is also relevant to the study's context.

Research question 3 was developed to explore the impact of teachers' use of AI-powered applications on reducing digital burnout, as indicated by dimensions such as digital aging, digital deprivation, emotional exhaustion, and the total score. The study's findings align with previous research highlighting the potential of technology, including AI, in mitigating burnout and stress in various professional contexts (Sharma et al., 2020). Specifically, the study contributes to this literature by demonstrating the positive effects of AI-powered applications on reducing digital burnout among teachers. The findings indicate that AI-powered applications, by aiding teachers in managing digital burnout, contribute to developing necessary skills for effective online teaching, aligning with Compton's focus on skills, roles, and responsibilities in online language teaching.

Additionally, the study resonates with Jamal (2023), who explored the role of AI in teacher education. The positive impact observed in reducing digital burnout aligns with Jamal's discussion on the opportunities

and challenges associated with AI in teacher education. Sharma et al. (2020) and Erten and Özdemir (2020) have addressed the issue of digital burnout, providing a theoretical framework for understanding its dimensions. The current study contributes empirically to this understanding, demonstrating that using AI-powered applications can effectively reduce digital burnout among teachers.

Conclusions and Implications

The findings offer valuable insights into the implications of AI-powered applications on teachers' autonomous behaviors, PD for online classes, and the reduction of digital burnout. In addressing the first research question, it was evident that teachers who integrated AI-powered applications into their practices experienced greater autonomy, as reflected in dimensions such as primary work processes, curriculum implementation, participation in decision-making at school, and the overall measure of autonomy. The study highlights the effectiveness of AI applications in fostering teacher autonomy, offering a significant avenue for enhancing professional behaviors.

Furthermore, as revealed in our findings related to the second research question, the positive outcomes in the PD for online classes underscore the potential of AI-powered applications in tailoring practical teacher training for online teaching modalities. The success in enhancing teachers' abilities and understanding in adapting PD practices to the online context signifies the adaptability and relevance of AI tools in the evolving landscape of online education.

In addressing the third research question, the study demonstrates the positive impact of AI-powered applications on reducing digital burnout among teachers. This aligns with broader discussions on the potential of technology, including AI, in mitigating burnout and stress (Sharma et al., 2020). The study contributes empirically to understanding digital burnout dimensions, emphasizing the practical benefits of AI applications in supporting teachers' well-being in a technologically driven educational environment.

These findings hold significant implications for educational stakeholders, policymakers, and practitioners. The study suggests that the strategic integration of AI-powered applications in teacher training and PD initiatives can lead to positive outcomes, enhancing autonomy and the ability to navigate online teaching challenges. Additionally, recognizing the role of AI in mitigating digital burnout highlights the need for a balanced and responsible use of technology in education. The study advocates for ongoing exploration and integration of innovative technologies to support teachers in their professional growth and well-being as the educational landscape evolves.

Limitations and Suggestions for Further Studies

The study, which examines the impact of educational AI on teachers' perceived autonomy, PD for online teaching, and digital burnout, is of great value in the field of modern education. By examining the integration of AI technologies into educational environments, the research provides valuable insights into how these tools impact teachers' autonomy and shape their role in the learning process. Additionally,

examining the impact of AI on PD in online teaching is critical to understanding how educators can leverage technology for continuous improvement. Additionally, the digital burnout research addresses a relevant issue in the digital age and highlights potential challenges and stressors that teachers may face when using AI-driven applications. The results of this study have the potential to influence education policy, guide the development of tailored AI tools to support educators, and improve the overall effectiveness of online education platforms.

While this study provides valuable insights into the impact of AI-powered applications on teachers' autonomous behaviors, PD for online classes, and the reduction of digital burnout, several limitations should be considered, paving the way for future research. First, the study's focus on a specific set of AI applications raises the need for broader investigations encompassing a diverse range of AI tools. Understanding how various AI interventions influence teacher practices and well-being could offer a more comprehensive view of the impact on education.

Second, the reliance on self-reported measures introduces potential biases. Future research could adopt a mixed-methods approach, combining qualitative methods such as observations and interviews with quantitative data to better understand teachers' experiences with AI applications. The sample, predominantly consisting of teachers from a specific geographic region and educational context, limits the generalizability of findings. Future studies should aim for a more diverse and representative sample, considering variations in educational levels, cultural backgrounds, and teaching environments. Furthermore, the study's short-term focus may not capture the long-term effects of AI integration. Longitudinal studies could provide insights into the sustained impact of AI-powered applications on teachers' practices, PD, and well-being over an extended period.

In line with the limitations of the study, comparative analyses to evaluate the effectiveness of different AI tools, qualitative investigations to deepen understanding, and contextualized research exploring factors influencing AI's impact are suggested. Additionally, cross-cultural studies, investigations into teacher training programs, and in-depth analyses of digital burnout dimensions could enhance our understanding of the multifaceted role of AI in education. By addressing these limitations and pursuing these research avenues, future studies can contribute to a more nuanced and comprehensive understanding of how AI shapes teacher autonomy, PD, and well-being in the evolving education landscape.

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