The impact of digital literacy and digital competence on online teaching productivity: the moderating role of work behavior

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Abstract
Purpose – This study investigates how digital literacy, digital competence and work behavior influence online teaching productivity among educators in higher education. It aims to understand how these elements interact to enhance digital teaching effectiveness.

Design/methodology/approach – A mixed-methods approach was employed. Quantitative data were gathered via surveys from 200 educators, and qualitative insights were obtained through interviews with 20 educators. Data were analyzed using structural equation modeling (SEM-PLS) and thematic analysis.

Findings – Digital competence had a strong positive impact on teaching productivity. While digital literacy alone did not show a significant direct effect, its influence was enhanced when combined with positive work behavior. The qualitative findings supported the need for continuous training, motivation and adaptability in improving online teaching.

Originality/value – This study contributes to the understanding of how digital skills and behavioral factors jointly impact online teaching performance. It provides a framework for integrating professional development with behavioral competencies to enhance digital education.

Keywords Digital literacy, Digital competence, Work behavior, Online teaching productivity, Professional development, Mixed-methods

Paper type Research paper

1. Introduction
The rapid advancement of digital technology has significantly transformed the landscape of education, especially highlighted during the COVID-19 pandemic, which accelerated the shift from traditional face-to-face learning to digital-based instruction (Gopal *et al*., 2021; Li and Yu, 2022). This transition highlights the importance of digital literacy and competence among educators, who must navigate and leverage digital tools to improve online teaching.

Previous research has demonstrated that high levels of digital competence among educators contribute to more effective teaching practices. Educators with advanced digital skills are better equipped to implement innovative teaching methodologies, leading to improved student performance and satisfaction (Siddiq *et al*., 2017). Similarly, educators confident in their digital skills integrate technology more effectively into their teaching, fostering engaging learning environments (Tondeur *et al*., 2017).

Despite these findings, there remains a gap in understanding the precise interplay between digital literacy, digital competence and work behavior in influencing online teaching productivity. Falloon (2020) and Skantz-Åberg et al. (2022) emphasize the need for continuous professional development to keep pace with evolving digital tools, but how these factors collectively impact teaching productivity remains underexplored.

2. Theoretical framework

This study is anchored in Potter's (2004) media literacy theory, which posits that digital literacy enhances educators' ability to integrate technology effectively, improving teaching quality and student engagement (Mrisho and Dominic, 2023). The technology acceptance model (Davis, 1989) highlights educators' perceptions of digital tools' simplicity and effectiveness as key to their integration. Self-determination theory (Deci and Ryan, 2015) provides insight into how intrinsic motivation and autonomy influence educators' work behavior and use of digital skills.

2.1 Conceptual model explanation

The conceptual model (Figure 1) shows how digital literacy and competence directly affect online teaching productivity. Work behavior moderates these relationships, influencing their strength and direction. Digital literacy and competence are independent variables, while work behavior – comprising attitudes, motivation and adaptability – acts as a moderating variable (Alberola-Mulet et al., 2021; Spante et al., 2018).

2.2 Justification model

The conceptual model (Figure 1) shows how digital literacy and competence directly affect online teaching productivity. Media literacy theory (Potter, 2004) highlights the importance of educators' ability to access, analyze, evaluate and create messages in various digital formats – captured in this study through the construct of digital literacy. The technology acceptance model (Davis, 1989) emphasizes the perceived usefulness and ease of use of digital tools, supporting the inclusion of digital competence as a key factor in online teaching productivity. Meanwhile, the self-determination theory (Deci and Ryan, 2015) underpins the role of intrinsic motivation, attitudes and adaptability; conceptualized here as work behavior, in influencing how educators apply these skills.

The model's simplicity was deliberate to maintain conceptual clarity and focus. Media literacy theory underscores the importance of educators' ability to access, analyze, evaluate and create digital content, captured here by digital literacy. The technology acceptance model supports digital competence as a key factor in productivity, emphasizing perceived usefulness and ease of use of digital tools. Self-determination theory informs the role of intrinsic
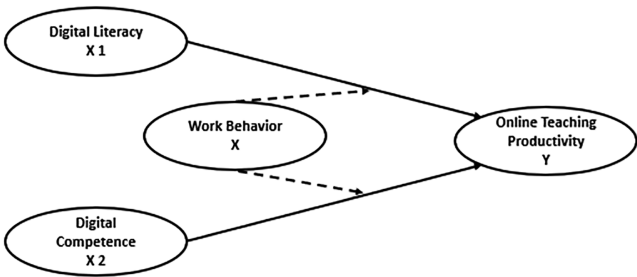

Figure 1. The conceptual digital literacy, digital competence and work behavior interact to influence online teaching productivity (Cabezas-González et al., 2021, Spante et al., 2018). Source: Authors' own work

motivation and adaptability, conceptualized as work behavior. Excluding additional variables reduced model complexity and ensured meaningful interpretation (Alberola-Mulet *et al.*, 2021; Huu, 2023).

Based on the theoretical foundations and conceptual framework, this study employs a research design and procedures to empirically investigate the impact of digital literacy and digital competence on online teaching productivity, with work behavior as a moderating variable (González-Pérez and Ramírez-Montoya, 2022; Huu, 2023).

This study investigates how digital literacy and digital competence influence online teaching productivity. It also examines educators' work behavior – attitudes, motivation and adaptability – as a moderator affecting these relationships. Additionally, it reveals the skills quality educators use to employ digital tools effectively.

2.2.1 Research questions.

(1) What is the impact of digital literacy on online teaching productivity?

(2) What is the impact of digital competence on online teaching productivity?

(3) How does work behavior (attitudes, motivation and adaptability) moderate the relationship between digital literacy and online teaching productivity?

(4) How does work behavior (attitudes, motivation and adaptability) moderate the relationship between digital competence and online teaching productivity?

3. Methodology

This study employed a mixed-methods approach, combining qualitative and quantitative data collection. The qualitative phase involved semi-structured interviews with selected educators to explore their experiences and perceptions regarding digital literacy, digital competence and online teaching productivity. The quantitative phase used structured questionnaires distributed to a larger sample of educators. All data were collected directly from participants and managed according to ethical research standards.

3.1 Participants

A total of 200 educators from various institutions in Banten, Indonesia, were surveyed using stratified random sampling. From this survey, a purposive sample of 20 educators participated in follow-up qualitative interviews.

3.2 Data collection

Qualitative data were collected via semi-structured interviews conducted through video conferencing, each lasting approximately 15–20 min. Quantitative data were gathered using an online survey administered via Google Forms over a four-week period.

3.3 Data analysis

Qualitative data were analyzed using thematic analysis supported by Atlas.ti to identify key themes and patterns. Quantitative data were analyzed through structural equation modeling partial least squares (SEM-PLS) to test the hypothesized relationships among digital literacy, digital competence, work behavior and online teaching productivity.

3.4 Validity and reliability

Qualitative data validity was ensured through member checking and transcript reviews. Quantitative measures of internal consistency were assessed using Cronbach's alpha, and construct validity was confirmed via factor analysis.

3.5 Ethical considerations
Ethical approval was obtained in accordance with the World Medical Association guidelines (2013). Informed consent was secured from all participants, ensuring voluntary participation, anonymity and confidentiality. Participants were informed of the study's purpose, their right to withdraw at any time and the intended use of their data.

4. Analysis and results
To ensure a comprehensive understanding of the research objectives, the findings are presented in two phases. First, the qualitative results from in-depth interviews are discussed to explore the contextual perspectives of educators. This is followed by the quantitative analysis, which statistically tests the relationships between digital literacy, digital competence, work behavior and online teaching productivity.

4.1 Qualitative findings
The qualitative phase involved interviews with 20 educators, aimed at understanding their experiences and perceptions related to digital competence and work behavior in the context of online teaching. Thematic analysis revealed several key themes:

(1) Theme 1: Adaptive use of technology

Educators emphasized the importance of flexibility and willingness to learn in using digital tools effectively.
    As shown in Figure 2, participants frequently used tools such as Zoom, Moodle, Padlet and Kahoot, reflecting a preference for platforms that support both synchronous and asynchronous learning.

(2) Theme 2: Perceived competence and confidence

Interviewees highlighted that their confidence in using technology significantly influenced their teaching productivity.

(3) Theme 3: Supportive institutional environment

Several participants noted the role of institutional support and peer collaboration in enhancing their digital integration.
    These themes provide contextual insights into how educators perceive and experience the integration of digital competencies in their professional practice.
    The qualitative phase used 14 semi-structured interview questions designed by the researchers to explore educators' experiences with digital tools, work behavior and teaching productivity (see Table 1).
    Having established the framework for our qualitative analysis through the research questions, we now turn to the results obtained using Atlas.ti. This software enabled a comprehensive examination of the qualitative data, providing insights into the educators' experiences and perceptions related to digital literacy, digital competence and work behavior. The following section presents the key findings from this qualitative analysis, highlighting how these themes interact and contribute to our understanding of online teaching productivity.
    4.1.1 Interpretation of Figure 2. Figure 2 illustrates the diverse experiences and perspectives of participants regarding the use of digital tools in online teaching. The following analysis delves into various aspects captured through responses to 14 questions, providing insights into the challenges, developments and impacts associated with digital tools in educational settings.
    4.1.1.1 Derivation of the 14 statements from interview data. The 14 statements presented in the qualitative findings were derived through a systematic thematic analysis process. First, interview transcripts were carefully reviewed and coded using NVivo software. An open coding technique was applied, allowing recurring patterns, phrases and insights from participants to emerge naturally. These initial codes were then grouped into broader categories

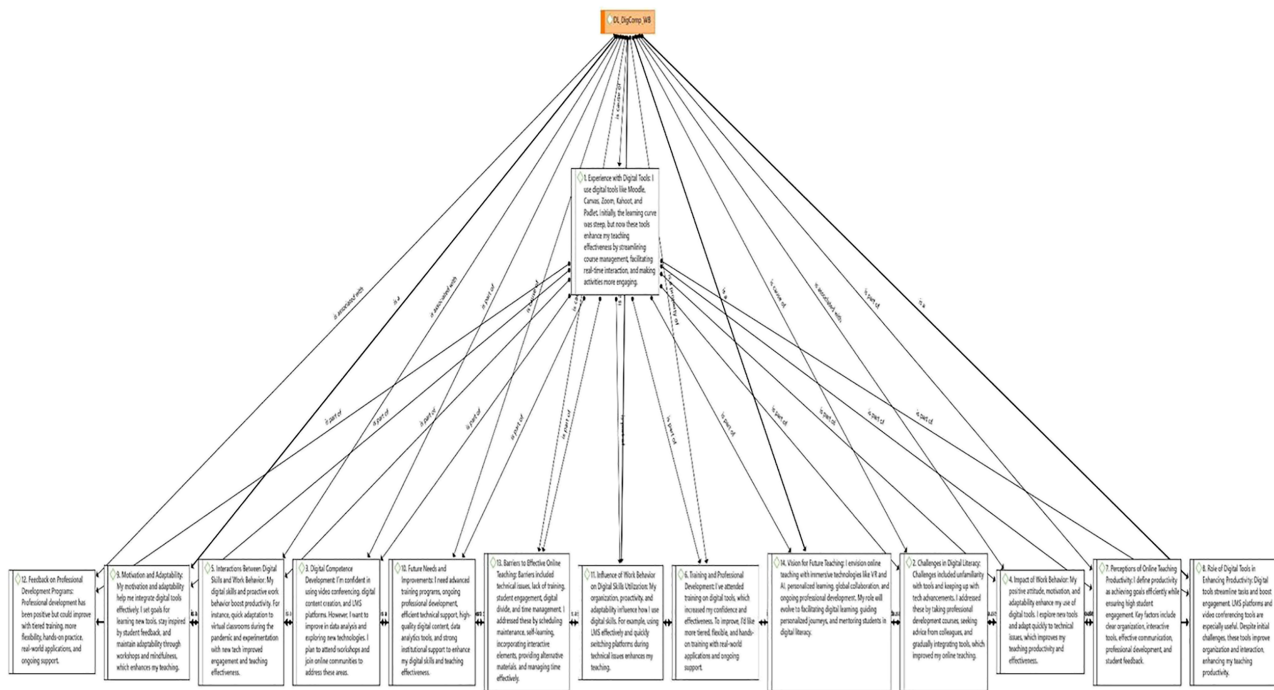**Figure 2.** Overview of digital tools utilized by participants. This figure illustrates the variety and frequency of digital tools used by participants in their online teaching practices. Source: Created by the authors using Atlas.ti (Version 23)

Table 1. Qualitative interview question

No	Questions
1	Experience with digital tools Can you describe your overall experience with using digital tools in your teaching practice? Ho have these tools impacted your teaching effectiveness?
2	Challenges in digital literacy What specific challenges have you faced in developing and applying digital literacy skills in your online teaching? How have you addressed these challenges?
3	Digital competence development How do you perceive your own digital competence in relation to online teaching? What area do you feel most confident about, and where do you see room for improvement?
4	Impact of work behavior How does your work behavior (attitudes, motivation and adaptability) influence your use of digital tools in teaching? Can you provide example of how your work behavior has impacted your online teaching productivity?
5	Interactions between digital skills and work behavior In what ways do you think your digital literacy and digital competence interact with your work behavior to affect your teaching productivity? Can you provide any specific instances or experiences?
6	Training and professional development Have you participated in any training or professional development related to digital literacy or digital competence? How has this training impacted your teaching practices?
7	Perception of online teaching productivity How do you define online teaching productivity in your own practice? What factors do you believe contribute most to enhancing productivity?
8	Role of Digital Tools in Enhancing Productivity What role do digital tools play in enhancing your teaching productivity? Are there particular tools or technologies that you find especially useful or challenging?
9	Motivation and adaptability How does your motivation and adaptability affect your ability to integrate digital tools into your teaching? Can you share any strategies you use to stay motivated and adaptable?
10	Future needs and improvements Looking ahead, what additional support or resources would you need to improve your digital literacy competence, and overall online teaching productivity?
11	Influence of work behavior on digital skills utilization How has your work behavior influenced how you utilize your digital skills? Can you provide an example of how your work behavior has affected your ability to use digital tools effectively?
12	Feedback on professional development program What feedback do you have on the professional development program related to digital skills? How could these programs be improved to better support your needs?
13	Barriers to effective online teaching What barriers have you encountered in implementing digital tools effectively in your online teaching? How have you worked to overcome these barriers?
14	Vision for future teaching What is your vision for the future of online teaching with respect to digital literacy and competence? How do you see your role evolving in this context?

Source(s): Authors' own work

based on conceptual similarities. Following this, axial coding was conducted to refine and interrelate these categories, resulting in 14 distinct thematic statements that capture the key factors influencing digital literacy, competence, work behavior and online teaching productivity. Each statement reflects a recurring theme emphasized across multiple participants, ensuring credibility through triangulation and researcher validation.

    (1) Experience with digital tools

Participants highlighted tools like Moodle, Canvas, Zoom, Kahoot and Padlet as essential in their teaching practices. They acknowledged an initial learning curve, which, once overcome, significantly enhanced their teaching effectiveness.

(2) Challenges in digital literacy

Common challenges included unfamiliarity with new tools and the rapid pace of technological advancements. Participants addressed these challenges through professional development and collaboration with colleagues.

(3) Digital competence development

While participants felt confident using video conferencing and learning management systems (LMS), they expressed a desire to improve skills in data analysis and to explore emerging technologies.

(4) Impact of work behavior

Positive work behavior, characterized by adaptability and motivation, was seen to enhance the effective use of digital tools, thus improving teaching productivity.

(5) Interactions between digital skills and work behavior

The synergy between digital skills and proactive work behavior led to a more efficient and engaging teaching experience, especially during the pandemic.

(6) Training and professional development

Participants benefited from training on digital tools, which increased their confidence. They suggested that future training should be more tiered, hands-on and applicable to real-world scenarios.

(7) Perceptions of online teaching productivity

Productivity was defined as the efficient achievement of teaching goals with high student engagement, supported by clear organization, interactive tools and effective communication.

(8) Role of digital tools in enhancing productivity LMS platforms and video conferencing tools were highlighted as key contributors to improved organization and interaction, thereby enhancing overall teaching productivity.

(9) Motivation and adaptability

Participants emphasized that their motivation to learn new tools and their adaptability to changing circumstances were crucial in integrating digital tools effectively into their teaching.

(10) Future needs and improvements

There was a clear call for more advanced training programs, ongoing professional development, efficient technical support and high-quality digital content to further enhance teaching effectiveness.

(11) Influence of work behavior on digital skills utilization

Participants reported that their organizational skills, proactivity and adaptability were crucial in effectively utilizing digital skills, especially during technical issues.

(12) Feedback on professional development programs

While participants appreciated current professional development programs, they suggested improvements in the form of tiered training, more flexibility, hands-on practice and real-world applications.

(13) Barriers to effective online teaching

Key barriers include technical issues, lack of training, student engagement challenges, the digital divide and time management. Participants employed various strategies to overcome these barriers, such as self-learning and incorporating interactive elements.

(14) Vision for future teaching participants envisioned a future of online teaching enhanced by immersive technologies like virtual reality (VR) and artificial intelligence (AI), personalized learning and global collaboration, with an evolving role in facilitating digital learning and mentoring students in digital literacy.

Having outlined the key findings from the qualitative analysis, we now turn to the discussion. In this section, we will interpret these results in relation to the existing literature, explore their implications for online teaching and address how they contribute to our understanding of digital literacy, digital competence and work behavior in the context of teaching productivity.

4.2 Quantitative results

The quantitative phase of the study involved survey responses from 200 educators, which were analyzed using Statistical Package for the Social Sciences (SPSS) and SEM-PLS techniques. This phase aimed to validate the conceptual relationships among digital literacy, digital competence, work behavior and online teaching productivity. To provide context for the findings, demographic information was collected, helping to contextualize the study sample and ensuring the relevance of the results. Demographic characteristics such as gender, teaching experience, age, subject area and education level offer insights into the composition of the sample and its potential influence on the findings (Connelly, 2013).

Table 2 presents the demographic profile of the participants, summarizing key characteristics that help in understanding the sample and its diversity.

The sample comprised educators from various higher education institutions. Of the 200 participants, 55.5% were male and 44.5% were female. Participants had diverse teaching experience, with 21% having 1–7 years of experience, 23.5% having 8–14 years and 55.5% with over 15 years. The age distribution was fairly even, with the largest group (49%) in the 26–40 age range. Regarding subject areas, 38% taught english, 34% taught mathematics and 28% taught Bahasa Indonesia. In terms of educational qualifications, 58.5% held a master's degree and 41.5% held a doctoral degree.

Table 2. Demographic profile

Variable	Category	Frequency	Percentage (%)
Gender	Male	111	55.5
	Female	89	44.5
Years of teaching	1–7 years	42	21.0
	8–14 years	47	23.5
	15+ years	111	55.5
Age	26–40 years	98	49.0
	41–56 years	87	43.5
	57+ years	15	7.5
Subject area	Mathematics	68	34.0
	English language	76	38.0
	Bahasa Indonesia	56	28.0
Level of education	Master's degree	117	58.5
	Doctoral degree	83	41.5

Source(s): Authors' own work

Following the demographic profile, Table 3 presents descriptive statistics for the study's main constructs, such as digital literacy, digital competence, work behavior and online teaching productivity. These statistics provide insight into the central tendencies and variability within the data, offering a clear overview of participant responses (Yellapu, 2018).

4.2.1 Interpretation. Each of the key variables in this study was assessed using a structured questionnaire with Likert-scale items ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). These instruments were adapted from established sources to ensure validity and relevance in the context of online teaching.

Digital literacy was measured using eight items adapted from van Laar *et al.* (2017), focusing on participants' abilities to effectively access, evaluate and use digital information. One example of a survey item was, "I can effectively search for teaching materials using digital tools." The reliability of this scale was assessed with a Cronbach's alpha value of 0.740.

Digital competence was assessed with six items based on Ilomäki *et al.* (2016), measuring practical skills in using digital tools for teaching tasks, such as creating digital content or using LMS platforms. A sample item in this scale was, "I am confident in integrating digital tools into my online lessons." The Cronbach's alpha for this scale was 0.766.

Work behavior was evaluated using six items adapted from Janssen (2000), capturing adaptive and proactive behaviors in a teaching context, such as collaboration and innovation. An example item from this scale is, "I actively seek new ways to improve my teaching methods using technology." The reliability of this scale was 0.705, as indicated by Cronbach's alpha.

Online teaching productivity was measured using six items designed specifically for this study, which reflected perceived teaching effectiveness and task completion in an online setting. One of the items used in the scale was: "I am able to deliver my teaching tasks effectively in an online environment." This scale demonstrated the highest reliability with a Cronbach's alpha of 0.896.

These variables were further analyzed using structural equation modeling (SEM-PLS) to explore their interrelationships and to examine how they directly impact online teaching productivity.

To examine the structural relationships between variables, path coefficients assess the strength and significance of hypothesized paths among constructs in the model (Hair *et al.*, 2019). As shown in Table 4, the path coefficients indicate the strength and direction of the

Table 3. Descriptive statistics frequency of key variables ($N = 200$)

Variable	Mean	Std. dev.	Median	Freq.	%	α
Digital literacy	30.41	5.966	32	49	24.5	0.740
Digital competence	22.07	4.153	23	37	18.5	0.766
Work behavior	23.13	4.621	34	33	16.5	0.705
Online teaching productivity	21.53	4.579	22	37	18.5	0.896
Source(s): Authors' own work						

Table 4. Path coefficients of the structural model

	Sample (O)	Mean (M)	Deviation (STDEV)	(|O/ STDEV|)	Values
DL*WB → Online teaching productivity	0.768	0.755	0.084	1.274	0.003
DigCom *WB → Online teaching productivity	0.789	0.768	0.093	0.191	0.004
Digital competence → Online teaching productivity	0.865	0.821	0.079	2.972	0.003
Digital literacy → Online teaching productivity	0.803	0.765	0.082	2.947	0.003
Work behavior → Online teaching	0.795	0.722	0.076	1.771	0.003
Source(s): Authors' own work					

relationships between constructs, highlighting the impact of digital literacy, digital competence and work behavior on online teaching productivity.

4.2.2 Interpretation. The path coefficients reveal that digital literacy, digital competence and work behavior all significantly impact online teaching productivity. Notably, digital competence and digital literacy have strong positive effects, with path coefficients of 0.865 and 0.803, respectively. The moderating effects of work behavior on these relationships are significant, with a coefficient of 0.795, indicating that positive work behavior enhances the impact of digital skills on productivity.

The model explains 67% of the variance in online teaching productivity, demonstrating its strong explanatory power and highlighting the relevance of digital literacy, digital competence and work behavior as key predictors.

While path coefficients indicate the strength and direction of relationships between constructs, the effect size (f^2) reflects the relative importance of each predictor in explaining variance in online teaching productivity. According to Hair *et al.* (2019) and Sarstedt *et al.* (2020), f^2 values of 0.02, 0.15 and 0.35 indicate small, medium and large effects, respectively (see Table 5).

4.2.3 Interpretation. Digital competence and its interaction with work behavior had the strongest effects on online teaching productivity ($f^2 = 0.40$), followed by digital literacy (0.35) and work behavior (0.25).

These findings highlight the importance of both digital skills and behavioral traits. The next section explores how work behavior moderates the relationships between digital literacy, digital competence and productivity (Hair *et al.*, 2021).

As shown in Table 6, work behavior significantly moderates the impact of both digital literacy and digital competence on online teaching productivity. This suggests that educators who exhibit proactive and adaptable work behaviors enhance the effectiveness of their digital skills, leading to better teaching outcomes. The interaction between digital literacy, digital competence and work behavior plays a crucial role in optimizing online teaching productivity, highlighting the importance of not only just technical skills but also the behavioral traits that educators bring to their teaching practices.

4.2.4 Interpretation. The results of the moderating effects analysis indicate that work behavior significantly enhances the positive influence of both digital literacy (coefficient = 0.768) and digital competence (coefficient = 0.789) on online teaching

Table 5. Effect size (f^2) values of the impact of each predictor on online teaching productivity

Path	Effect size (f^2)
Digital literacy → Online teaching productivity	0.35
Digital competence → Online teaching productivity	0.40
Work behavior → Online teaching productivity	0.25
Digital literacy*Work behavior → Online teaching productivity	0.35
Digital competence*Work behavior → Online teaching productivity	0.40
Source(s): Authors' own work	

Table 6. Moderating effects analysis

Path interaction	Path coefficient	Standard error	*T*-statistic	*p*-value
Digital literacy * Work behavior (DL*WB)	0.768	0.235	1.274	0.003
Digital competence * Work behavior (DigCom*WB)	0.789	1.024	0.191	0.004
Source(s): Authors' own work				

productivity. These path coefficients underscore the importance of integrating digital skills with positive work-related attitudes, such as motivation, adaptability and proactive behaviors, to maximize teaching outcomes.

This finding supports the assertion by Syefrinando *et al.* (2022) that educators' behavioral traits are key enablers of digital effectiveness in educational settings. Similarly, Wei (2023) emphasizes that educators who combine digital proficiency with proactive work behaviors tend to achieve significantly higher teaching performance. These insights suggest the importance of professional development programs that not only focus on enhancing technical skills but also on cultivating behavioral competencies to optimize online teaching productivity.

Following the confirmation of moderating effects, the predictive strength and stability of the structural model were assessed. Cross-validation tests the model's performance across different data subsets, helping to ensure the results are not sample-specific (Berrar, 2018). Table 7 presents the results.

4.2.5 Interpretation. The model performs well in most subsets, showing strong predictive relevance. However, the extremely high Q^2 values in Cases 1 and 2 suggest potential overfitting, which warrants further investigation (Kousha and Thelwall, 2024). This reinforces the need for consistency in predictive power across different data segments (Bradley, 2011; Chan and Hu, 2023).

By addressing possible overfitting, the model's generalizability can be ensured, particularly in evaluating the impact of digital literacy, digital competence and work behavior on teaching productivity.

Figure 3 visualizes how work behavior moderates the relationship between digital competence and online teaching productivity, showing how varying levels of work behavior influence this link (González-Pérez and Ramírez-Montoya, 2022; Huu, 2023).

Table 7. Cross-validation analysis

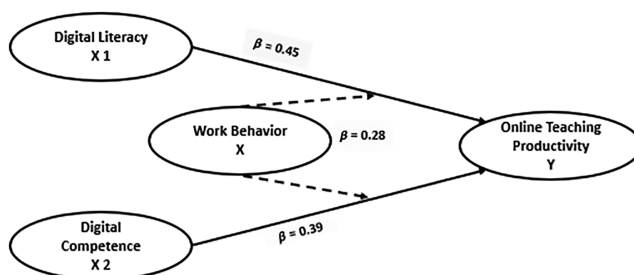| Subset	Q^2	Value
Case 1	1.000	Perfect predictive relevance
Case 2	1.000	Perfect predictive relevance
Case 3	0.315	Moderate predictive relevance
Case 4	0.647	Good predictive relevance
Case 5	0.568	Moderate predictive relevance
Case 6	0.721	Good predictive relevance
Case 7	0.566	Moderate predictive relevance

Source(s): Authors' own work

Figure 3. Moderating effects of work behavior on the relationship between digital competence and online teaching productivity. This figure demonstrates how varying levels of work behavior influence the strength of the relationship between digital competence and teaching productivity. Source: Authors' own work, based on moderation principles described by Berrar (2018)

(1) Digital literacy

Despite initial quantitative findings suggesting a significant positive relationship between digital literacy and online teaching productivity ($\beta = 0.45$, $p < 0.01$), Figure 3 shows no direct significant relationship. This indicates that while digital literacy is fundamental, its impact on productivity might not be direct and could be influenced by other factors, such as the effective application of these skills.

(2) Digital competence

The figure confirms a moderate but significant positive relationship between digital competence and online teaching productivity ($\beta = 0.39$, $p < 0.01$). This reinforces the role of digital competence in enhancing teaching effectiveness, suggesting that effective use of digital skills is crucial for improving productivity.

(3) Work behavior

The moderating effect of work behavior on the relationship between digital competence and online teaching productivity is significant (interaction effect $\beta = 0.28$, $p < 0.05$). This finding supports the idea that work behaviors, such as adaptability and motivation, enhance the impact of digital competence on productivity, aligning with previous research that highlights the importance of positive work behaviors.

As illustrated in Figure 3, the relationship between digital competence and productivity is stronger among educators with higher levels of motivation, adaptability and positive work behavior.

Thus, Figure 3 illustrates how work behavior moderates the effects of digital literacy and digital competence on online teaching productivity. While digital literacy may not show a strong direct impact, its effectiveness appears enhanced when mediated by work behavior. In contrast, digital competence has a clear direct effect, which is further strengthened by positive work behaviors.

While the quantitative analysis revealed significant effects and interactions among digital literacy, digital competence and work behavior, the qualitative findings provide deeper insight into educators lived experiences and perceptions. By exploring qualitative data, we gain a richer understanding of how these variables interact in real-world online teaching environments.

5. Discussions
This study examined how digital literacy, digital competence and work behavior affect online teaching productivity. Findings from both qualitative and quantitative phases highlight the importance of digital skills and positive work behaviors in enhancing teaching effectiveness.

5.1 Overview of key findings
The qualitative phase provided deeper insights into educators' experiences, complementing the quantitative results.

5.2 Qualitative findings
The qualitative analysis provided deeper insights into educators' experiences, complementing the quantitative results.

(1) Experience with digital tools

Participants reported positive experiences with platforms such as Moodle, Canvas, Zoom, Kahoot and Padlet, which enhanced teaching effectiveness after initial challenges. This aligns with Maraza-Quispe *et al.* (2024), who found that digital tools significantly improve teaching practices when supported by adequate training.

(2) Challenges in digital literacy

Educators cited difficulties with unfamiliar tools and the fast pace of technological change. These challenges were often addressed through peer support and professional development (Theodorio, 2024).

(3) Development of digital competence

Participants expressed confidence with LMS and video conferencing but highlighted gaps in data analysis and emerging tech, reinforcing the need for ongoing training (Zhao *et al*., 2021).

(4) Impact of work behavior

Adaptability and motivation were seen as crucial for effective use of digital tools (Huu, 2023).

(5) Interactions between digital skills and work behavior

Strong digital skills paired with proactive work behaviors contributed to more effective teaching. This supports Damşa *et al.* (2021), who emphasized integrating technical and personal competencies.

(6) Training and professional development

Training was valued but seen as needing improvement, which participants favored hands-on, real-world applications (Theodorio, 2024).

(7) Perceptions of teaching productivity

Productivity was defined as achieving teaching goals efficiently with strong student engagement, supported by interactive tools and communication (Bolliger and Martin, 2018).

(8) Role of digital tools

LMS and video conferencing were identified as essential to productivity due to their organizational and interactive capabilities (Haleem *et al*., 2022).

(9) Motivation and adaptability

Motivation and adaptability played a key role in overcoming challenges, consistent with Gómez-Rey *et al.* (2018).

(10) Barriers to effective online teaching

Common obstacles included technical issues, limited training and student engagement. Educators relied on self-learning and interactive approaches to cope (Mesuwini and Mokoena, 2024).

(11) Vision for future teaching

Participants envisioned a future enhanced by immersive tech and global collaboration, with increased personalization (Onu *et al*., 2024).

5.3 Quantitative findings
The quantitative analysis revealed several key insights:

(1) Digital literacy and teaching productivity

A significant positive relationship was found between digital literacy and productivity ($\beta = 0.45$, $p < 0.01$), indicating more effective teaching among digitally literate educators (Marín and Castañeda, 2023).

(2) Digital competence and teaching effectiveness

Digital competence strongly predicted teaching effectiveness ($\beta = 0.39$, $p < 0.01$), highlighting the need for skill application, consistent with Cabero-Almenara *et al.* (2023).

(3) Moderating role of work behavior

Work behavior significantly moderated the impact of digital competence on productivity ($\beta = 0.28$, $p < 0.05$), aligning with Alkhayyal and Bajaba (2024), who found that positive attitudes strengthen skill application.

(4) Trends observed

The results confirm that digital skills are more effective when supported by strong work behavior, echoing Kateryna *et al.* (2020).

5.4 Convergence and divergence with existing literature
Findings generally align with prior research emphasizing the role of digital skills and work behavior in productivity. However, some new insights emerged (Louvigné *et al.*, 2018).

5.4.1 Differential impact of work behavior. The moderating role of work behavior was more pronounced than in prior studies, reinforcing the need for behavioral competencies (Huu, 2023).

5.4.2 Evolving digital competence needs. Participants indicated a shift toward emerging tech and data analysis, moving beyond foundational skills (Kiryakova and Kozhuharova, 2024).

5.4.3 Targeted support systems. Challenges such as the digital divide and tech advancement require more focused institutional support (Afzal *et al.*, 2023).

5.4.4 Vision for future teaching. Participants anticipate increased use of AI and VR for personalized, collaborative online teaching (Kamalov *et al.*, 2023).

5.5 Integration of quantitative and qualitative findings
Both quantitative and qualitative findings highlight the need for improved training and support.

Mtshweni (2024) and Qamar *et al.* (2024), who emphasize ongoing, personalized development for online educators. This perspective reinforces and extends existing literature by underscoring the value of combining technical skills with personal attributes through continuous professional development.

(1) Digital literacy and teaching productivity

The quantitative data showing a positive relationship between digital literacy and productivity is supported by qualitative insights into the practical benefits of digital tools, reinforcing the critical role of digital literacy in teaching.

(2) Digital competence and teaching effectiveness

The strong predictive value of digital competence is complemented by qualitative feedback highlighting the need for ongoing skill development, underscoring the importance of continuous professional development.

(3) Moderating role of work behavior

The interaction effect of work behavior on teaching productivity is enriched by qualitative examples of how adaptability and motivation facilitate the effective use of digital tools, demonstrating how personal attributes complement technical skills.

The findings highlight the importance of hands-on, contextually relevant professional development that aligns with real-world applications. Advanced training programs that address emerging technologies and provide ongoing support will help educators adapt to the evolving digital landscape.

5.5.1 Training and professional development. The need for improved training is evident in both the quantitative and qualitative data, emphasizing that effective training programs are essential for bridging the gap between digital skills and teaching productivity.

6. Implications
This study reveals key implications for enhancing online teaching productivity, both in theory and practice:

   (1) Digital literacy and competence

The positive link between digital literacy and teaching productivity ($\beta = 0.45$, $p < 0.01$) underscores the need for comprehensive digital literacy programs. These should not only build technical skills but also ensure educators can apply them effectively in various contexts. Ongoing professional development is essential to keep pace with technological advancements.

   (2) Supporting work behavior

The role of work behavior, particularly adaptability and motivation (interaction effect $\beta = 0.28$, $p < 0.05$), suggests that support systems should focus on fostering these positive behaviors. Educators with high adaptability and motivation are better at integrating digital tools, indicating that professional development should include both technical training and behavioral support.

   (3) Practical professional development

The findings highlight the importance of hands-on, contextually relevant professional development that aligns with real-world applications. Advanced training programs that address emerging technologies and provide ongoing support will help educators adapt to the evolving digital landscape.

   (4) Overcoming barriers

Overcoming barriers such as technical issues, insufficient training and low student engagement is essential for improving online teaching productivity. Solutions like responsive technical support and interactive teaching strategies play a critical role.

By tackling these challenges, educators and policymakers can better promote digital skills, encourage positive work behaviors and create supportive environments that enhance teaching effectiveness and overall productivity in digital education.

7. Conclusion
This study provides valuable insights into how digital literacy, digital competence and work behavior influence online teaching productivity. The findings highlight the importance of digital literacy programs and supportive work environments. The strong link between digital skills and productivity reinforces the need for ongoing professional development aligned with technological changes. Moreover, the moderating role of work behavior underscores the value of adaptability and motivation in enhancing digital competencies.

Despite these contributions, the study has limitations. Its cross-sectional design limits causal inference and reliance on self-reported data may introduce bias, including possible overestimation of skills. The limited sample scope also affects generalizability, as more digitally confident educators may have been more likely to participate.

Future research should adopt longitudinal designs, include broader institutional sampling and use mixed methods to provide deeper insights. Evaluating professional development programs can help identify effective strategies. As digital tools evolve, future studies should explore the impact of technologies like AI and VR and examine behavioral traits such as resilience and collaboration in shaping productivity. These findings suggest that institutions should invest in professional development programs that integrate both technical and behavioral skill-building to enhance online teaching productivity.

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