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THE IMPACT OF DIGITAL TOOLS ON NURSING STUDENTS' CLINICAL PERFORMANCE: A MEDIATING ROLE OF COGNITIVE LOAD

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ABSTRACT

The clinical performance of nursing students is a big problem in the era of modern technological advancement. With advancements in artificial intelligence and technology, clinical performance strategies with modern technology are required for nursing students. However, in the contemporary clinical environment of competition, a high level of performance is needed from nursing students. This research was conducted to investigate the impact of digital literacy level, instructor support for digital learning, and lack of technology anxiety on cognitive load and clinical performance. Furthermore, the study also investigated the direct impact of a lack of cognitive load on clinical performance. The mediating role of cognitive load in the relationship between digital literacy level, instructor support for digital learning, technology anxiety, and clinical performance was also investigated. A sample of 305 nursing students was collected from China using purposive sampling. This study used a Partial Least Squares – Structural Equation Model (PLS-SEM) to investigate the complex relationships presented in the framework. The study found that digital literacy level, instructor support for digital learning, and lack of technology anxiety have a significant impact on cognitive load and clinical performance. At the same time, the mediating role of lack of cognitive load between digital literacy level, instructor support for digital learning, lack of technology anxiety, and clinical performance was also accepted. The findings of this research provide new insights into clinical performance and nursing literature and recommend actionable practices for advancing the students' clinical performance in China.

INTRODUCTION

China's health professional education faces a dual challenge, elevating students' clinical performance while preventing excessive cognitive load in increasingly digital learning environments (Sun et al., 2021). As hospitals and universities expand electronic health records, high-fidelity simulation centers, and AI-enabled decision support, students must master unfamiliar interfaces alongside complex clinical reasoning (Pawar & Vispute, 2024). This overlay of technological demands on already intensive curricula can saturate working memory and depress performance during bedside care. Moreover, the rapid nationwide expansion of online and blended instruction since the pandemic has widened variability in students' digital readiness and access to high-quality instructional support (Werfhorst et al., 2022). Clinical placements, often in high-volume urban settings, add time pressure and documentation burdens that intensify cognitive demands. The practical problem is thus not merely technological adoption but aligning instructional design and faculty support with learners' digital literacy so that technology reduces, rather than amplifies, mental load (Yu, 2022). When digital ecosystems, instructor practices, and student competencies are misaligned, learners experience disorientation, anxiety, and inefficiency at precisely the moment when accuracy, speed, and patient-centered judgment are required (Tammets et al., 2022). Addressing this misalignment is essential to secure safe, effective clinical learning and to translate China's substantial investment in digital health education into consistent improvements in learners' clinical performance.

Unresolved misalignment between digital demands and learner capacity produces consequences that reverberate across students, patients, and institutions (Lattouf, 2022). At the student level, excessive cognitive load increases error

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proneness, slows clinical reasoning, and hinders the transfer of classroom knowledge to practice (Thornby et al., 2023). Furthermore, heightened technology anxiety magnifies avoidance, undermines self-efficacy, and increases attrition risk during demanding clinical rotations. Over time, these strains accumulate as fatigue and burnout, eroding professional identity and willingness to engage in reflective learning (Kong et al., 2023). For patients, reduced clinical performance can manifest as delayed interventions, documentation inaccuracies, and weaker continuity of care, particularly in fast-paced wards where trainees shoulder heavy information management tasks (Lustberg et al., 2023). Institutionally, variable performance undermines confidence in costly digital learning infrastructure and simulation investments, while widening disparities between well-resourced urban centers and less well-resourced rural areas. At the same time, faculty face heavier supervisory burdens and must remediate basic digital competencies rather than coach higher-order clinical judgment (Lewis, 2023). At the system scale, uneven readiness slows health information integration and constrains the value of nationwide digitization initiatives, limiting data quality, interoperability, and analytics readiness (Goodacre et al., 2023). The cumulative impact is a vicious cycle: technology intended to streamline practice inadvertently increases mental load, which depresses performance, which in turn reduces the perceived utility of digital tools and discourages further pedagogical innovation for trainees alike.

On the other hand, timely action is imperative because the forces amplifying cognitive load and performance variability are accelerating, not abating. China's population is aging, the burden of chronic disease is increasing, and care models are shifting toward data-intensive, team-based practice (Su et al., 2023). Simultaneously, hospitals are deepening adoption of electronic records, clinical decision support, and AI-enabled triage, expanding the quantity, velocity, and complexity of information that trainees must process (Liang et al., 2021). If educational design does not proactively cultivate digital literacy, reduce technology anxiety, and provide consistent instructor support, the gap between curricular preparation and workplace reality will widen. Post-pandemic reforms have opened a narrow window to re-architect digital pedagogy, refresh assessment, and institutionalize simulation; missing this window risks path dependence on suboptimal practices that normalize high mental load (Vallo Hult et al., 2023). According to scholars, disparities in students' digital readiness and access threaten equity goals, as learners from less-resourced settings may encounter disproportionately higher cognitive barriers. Addressing the problem now can prevent a productivity penalty in the future workforce, protect patient safety, and accelerate return on investment in national digitization. It can also ensure that emerging AI tools augment, rather than distract from, core clinical reasoning. Therefore, without timely remediation, today's instructional frictions could harden into structural deficits tomorrow.

This study aims to address these challenges by empirically modeling how digital literacy, instructor support for digital learning, and a lack of technology anxiety influence students' clinical performance, both directly and indirectly through reduced cognitive load. Based on the comprehensive and novel framework, the study tested a set of hypotheses specifying: (a) direct associations between digital literacy, instructor support, and lack of technology anxiety with reduced mental burden and higher performance; and (b) the mediating role of lack of cognitive load linking these antecedents to clinical outcomes. The study objective was twofold: to quantify effect sizes among these constructs within Chinese clinical education settings, and to identify leverage points for instructional and organizational design. Conceptually, we contribute by reframing the lack of cognitive load as a desirable instructional state that can be systematically engineered through the alignment of learner competencies and pedagogical supports, rather than treating it as a passive by-product. Empirically, the study extends the literature by examining these relationships in a digitally transforming healthcare education ecosystem, where contextual pressures are acute and policy ambitions high. Practically, the study translates findings into design principles for faculty development, curriculum sequencing, and technology procurement that target reductions in mental load while enhancing meaningful performance. For this purpose, this study used quantitative data collected from nursing students to analyze the relationships between variables.

However, the study's novelty lies in jointly foregrounding a lack of technology anxiety and a lack of cognitive load as positive, engineerable states, and then embedding them within a coherent model that links learner competencies, instructional support, and clinical performance in China's digitizing education system. Rather than treating anxiety and cognitive load as incidental symptoms, this study conceptualizes them as design targets that administrators and faculty can influence through policies, infrastructures, and pedagogies. By testing mediation, the study identified the mechanism through which digital literacy and instructor support translate into performance, offering a diagnostic lens for where to intervene when outcomes stall. This mechanism-focused approach yields broader implications. For institutions, results can inform investments in learning technologies, faculty capability building, and simulation design that reduce mental load while improving bedside competence. For policymakers, evidence can guide digital education standards that emphasize usability, support, and learner preparedness alongside content coverage. For technology vendors, findings highlight requirements for workflow-aligned interfaces and just-in-time guidance in student systems. Beyond China, the framework is portable to other health education systems navigating rapid digitization and workforce pressure, especially in emerging economies. By centering low-anxiety, low-load learning as a strategic objective, the study reframes digital transformation as a human-performance initiative with scalable impact. The second section is based on a review of the literature and the development of hypotheses. The third section is based on methodology, while the fourth section is based on analysis and presentation of data. The fifth section of this study is about discussion, followed by conclusion, implications, and future directions.

LITERATURE REVIEW

Digital literacy is becoming increasingly recognized as an essential competence for students engaging with technology-related education. Digital literacy is defined as the ability to effectively access, evaluate, and use digital technologies for academic and professional purposes (Rehman et al., 2024). More specifically, digitally literate students can access relevant

content on online platforms, clinical technologies, or digital resources to enable them to complete a learning task, and are likely to require less cognitive and physical load (Skulmowski & Xu, 2022). Peng and Yu (2022) acknowledge that extraneous load occurs when learners must use mental energy to learn irrelevant things. In situations where students do not have digital literacy, they could spend inordinate amounts of time attempting to troubleshoot their technical problems, redirecting their attention away from learning and cognitive burden (Kabakus et al., 2023). Furthermore, digital competence has also been related to decreased cognitive load and increased engagement with simulation-based learning and electronic health records in health professions education (Holm, 2025). In essence, digital literacy is a cognitive enabler, reduces uninformative processing, and frees cognitive resources to do something meaningful with knowledge.

Instructor support is one of the most important factors in the adjustment of learners in a digital learning environment (Susan, 2023). Supportive teaching behaviours, which include the provision of information, technical help, and feedback, can lower the cognitive load for students (Kang et al., 2021). Ha and Lim (2023) found that students who believed they received high levels of instructor support reported lower levels of frustration and disorientation in their online courses. By providing scaffolds for student learning, instructors help to manage the extraneous cognitive load for the student and create a space to allow the learner to focus on more meaningful learning (Arrogante et al., 2021). In digital healthcare education, which includes clinical simulations and dynamic, complex systems, instructors play a crucial role in reducing cognitive load by managing expectations and overcoming technical difficulties (Imanipour et al., 2022). Without the support from an instructor, students could be using much energy problem-solving significant technical problems and not spending that same energy to learn meaningfully (Fooladi et al., 2022). Therefore, instructor support acts as a motivational and cognitive resource that can improve the overall digital experience but lessen the imposed or extraneous load on the learner's cognitive load.

Technology anxiety refers to the mental uneasiness or dread experienced by learners when using digital tools (Theobald et al., 2021). Chang et al. (2021) indicate that the presence of high technology anxiety increases a learner's extraneous cognitive load because the learners now must engage cognitive resources to manage their anxiety instead of utilizing those resources toward performing the task at hand (Rogers & Franklin, 2021). Learners with less anxiety would feel more confident with the digital platforms and therefore would have less extraneous processing. Azher et al. (2023) indicate that confidence in their ability to use technologies alleviates the learners' anxiety, thus allowing them to focus on the task they are required to complete. When a learner is engaged in a digital learning context, the decreased cognitive load leads to a greater degree of engagement with less emotional response. In learner populations with low technology anxiety, the literature shows that they possess better problem-solving approaches and improved focus in learning situations (Bolatli & Kizil, 2022). In terms of healthcare education, decreased anxiety allows the learners to engage with simulation technologies and electronic patient records without some of the cognitive overloads that may undermine their learning (Wilson et al., 2022). When affective barriers are lessened, a lack of technology anxiety provides a more straightforward cognitive pathway for more efficient cognitive processing and improved learning.

Digital literacy not only removes cognitive barriers but is an essential component of clinical competence. Within healthcare education, digital technologies such as simulation, electronic health records, and diagnostic tools are ubiquitous; therefore, the inclusion of digital competence is critical (Kim & Shin, 2021). Specifically, students with appropriate digital literacy have more capacity for integrating the technology into their clinical practice, which will lead to enhanced diagnostic reasoning and decision making (Yeşilyurt & Vezne, 2023). Previous research suggests that digital dexterity enhances learners' confidence and ability to interact with complex environments (Kabakus et al., 2023). Furthermore, confidence affects performance through practical tasks where technology is embedded. Bahari (2023) suggests that if the learner does not struggle with the technological tools, they can allocate the cognitive demand to higher-order problem solving, improving the clinical outcome. In previous studies in nursing and medical education, students with significantly greater digital literacy have demonstrated greater efficiency and accuracy in simulation-based assessments (Giudice da Silva Cezar & Maçada, 2021). Overall, digital literacy offers cognitive and practical benefits, enabling students to transition from digital competence to clinical competence and ultimately achieve professional readiness.

Instructor support is widely recognized as the foremost contributor to student success in online learning environments. Pawar and Vispute (2024) emphasize that support through well-structured scaffolds, timely feedback, and technical assistance fosters a productive learning environment where learning and skill development thrive. In healthcare disciplines, instructors also help students transition into practice by helping bridge the digital tools into clinical application (Sun et al., 2021). Instructor support can help students transition from education to practice and provide a smoother integration of the skills and digital tools learned (Hawes & Arya, 2023). Learners who receive high levels of instructor support experienced low levels of uncertainty, increased motivation to engage in practice, and greater self-efficacy (Na & Roh, 2021). This supportive educational climate can help students engage with their learning about digital content and also provide support for practical clinical activities. Furthermore, instructor feedback provides spaces for reflective learning, where students can integrate their digital competencies while refining their clinical skills (Sim et al., 2022). Werfhorst et al. (2022) illustrate that students whom supportive instructors guide do better in clinical simulation and assessment environments. Supporting students with scaffolding and guidance helps learners distinguish content learning from knowledge about the tools they are using, mitigating technology barriers. Therefore, instructor support is not only a moderator of cognitive load, but also an enabler of clinical competence.

Complications associated with anxiety toward technology can inhibit students' application of knowledge at the clinical level (Guerrero et al., 2021). High levels of anxiety toward technology tools likely cause avoidance behaviours, decrease motivation, and diminish concentration (Yin et al., 2024). In the context of healthcare education, where simulation activities and electronic health records are increasingly prevalent, anxiety related to technology can impact a student's ability to perform (Tzafilkou et al., 2021). When learners experience a reduced level of anxiety, they approach clinical tasks with

confidence, which allows them to apply their knowledge and skills more effectively. Mauriz et al. (2021) suggest that anxiety reduction produces competence, which correlates with an improved performance outcome. Evidence suggests that students who experience decreased levels of technology anxiety tend to demonstrate increased competence when using simulation-based training and more accurate diagnostic reasoning (McVeigh et al., 2021). Less anxious students can take feedback fully from their instructor, which contributes to a higher sense of competence (Nooijen et al., 2024).

The study Yu (2022) maintains that the amount of information the average human working memory can hold is finite; when surpassed, performance and learning are impaired. In clinical education, cognitive load is critical because students must learn to combine and fluidly integrate theoretical knowledge, skills, and behaviours with time restrictions (Jallad & Işık, 2022). When cognitive load is not a concern, learners can allocate their cognitive resources toward clinical reasoning and procedure tasks essential to their learning, rather than on useless or extraneous demands (Zhao et al., 2023). The literature in health education training indicates that students who experience a lower cognitive load can perform more effectively in simulations and assessments, and that cognitive load influences their cognitive resources away from learning and toward problem-solving and decision-making (Bolatli & Kizil, 2022). Furthermore, cognitive overload has been shown to increase error rates, decrease retention, and decrease diagnostic accuracy (Kwak et al., 2022). On the other hand, when instructional designs and any supporting mechanisms alleviate unnecessary load, students' clinical competence significantly improves. This suggests that a lack of cognitive load allows learners to allocate their limited cognitive resources better, improving their performance in clinical practice.

Digital literacy and clinical performance are not only directly related but also indirectly related through the cognitive load (Berdida, 2023). The more digitally literate learners can better utilize educational technologies, lessening extraneous cognitive load (Chang et al., 2021), freeing up attention to focus on clinical and deeper learning, which enhances performance (Tammets et al., 2022). Empirical evidence demonstrates that digital competence leads to less frustration and more engagement in clinical-related tasks, particularly when dealing with complicated simulation media and electronic patient records in clinical placements (Theobald et al., 2021). However, with high cognitive load, even digitally literate learners may have compromised efficiency because of the mental resources consumed with technology management (Lattouf, 2022). As a result, the ability of digital literacy to enhance clinical performance is dependent on levels of cognitive load. In cases of minimal cognitive load, digital literacy acts on clinical competence without the limiting effects of the cognitive load. Thornby et al. (2023) report that cognitive processing efficiency acts as the link between the technological abilities of learners and actual applied practice performance.

Instructor support is critical in both directly changing clinical performance and facilitating the cognitive processes behind performance. As Kwak et al. (2022) note, adequate instructor support reduces cognitive load as instructors can assist with expectations, troubleshoot problems, and provide feedback in a structured way. This support allows students to allocate their cognitive resources to the clinical tasks rather than dealing with an excess of information and potential complexity from technology or instructor directions (Huai et al., 2024). The mediating effect of cognitive load can be illustrated by problems where instructor support allowed students to engage the digital interface with minimal examples of cognitive load (Lavoie-Tremblay et al., 2021). When supporting blended learning activities, learner outcomes should depend more on improved clinical competence than on the manner of digital interface delivery (Lapierre et al., 2022). Both nursing and medical education literature have highlighted that learners who identified higher instructor support reported reduced cognitive load, and the decreased cognitive load leads to improved diagnostic accuracy and clinical reasoning.

According to Chen et al. (2022), finding technology anxiety has been targeted to the increase in cognitive load, as learners who are anxious devote cognitive energy to manage their anxiety, as opposed to focusing on a learning task. As cognitive load increases, student performance can deteriorate in both digital and clinical learning environments (Hawes & Arya, 2023). On the other hand, if students experience little technology anxiety, they engage with digital tasks with more confidence, resulting in lower mental load and improved clinical performance (Wilson et al., 2022). According to Sim et al. (2022), students who have confidence in managing technology spend less time in extraneous processing, which allows them to engage fully in the particulars of clinical reasoning. Research also indicates that students who have little technology anxiety perform better in simulation-based training and demonstrate more situation shifting in clinical decision-making (Azher et al., 2023). The effects of cognitive load are apparent, as decreased anxiety results in fewer cognitive demands, which ultimately allows for better performance (Jallad & Işık, 2022). Cognitive load works to mediate how lack of technology anxiety contributes to developing students' clinical skills and professional readiness. Based on a review of the literature, inconsistencies exist in the relationships between variables across different contexts. Hence, the following hypotheses are developed in this study. Furthermore, this study aims to investigate the empirical evidence for testing the following hypotheses.

H_1: Digital literacy level is positively associated with a lack of cognitive load.

H_2: Instructor support for digital learning is positively associated with reduced cognitive load.

H_3: Lack of technology anxiety is positively associated with lack of cognitive load.

H_4: Digital literacy level is positively associated with clinical performance.

H_5: Instructor support for digital learning is positively associated with clinical performance.

H_6: Lack of technology anxiety is positively associated with clinical performance.

H_7: Lack of cognitive load is positively associated with clinical performance.

H_8: Lack of cognitive load mediates the relationship between digital literacy level and clinical performance.

H_9: Lack of cognitive load mediates the relationship between instructor support for digital learning and clinical performance.

H_{10}: Lack of cognitive load mediates the relationship between technology anxiety and clinical performance.

The model used in this study, illustrating the relationship between variables, is presented in Figure 1.

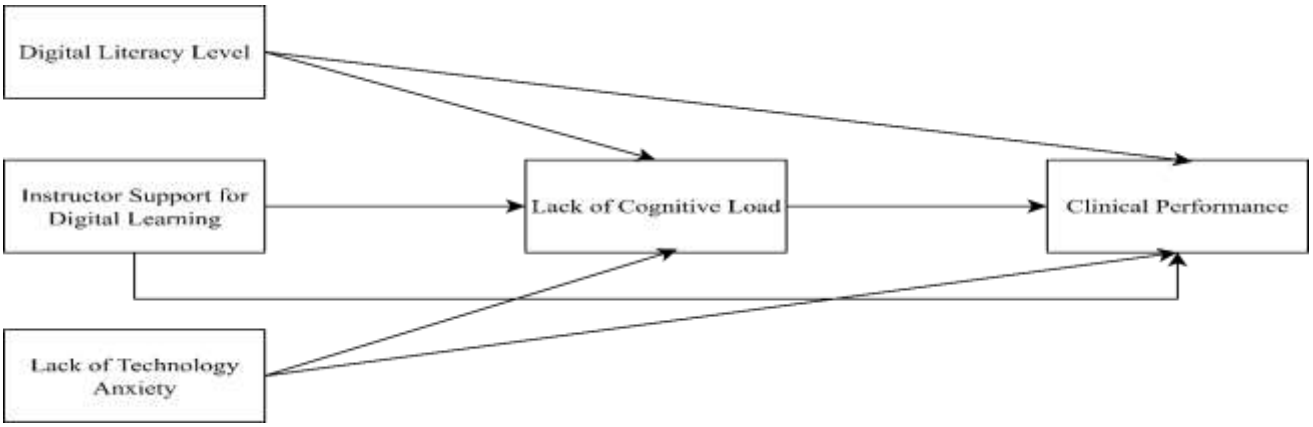

Figure 1. Research Framework

MATERIALS AND METHODS

This research was based on quantitative data, where respondents were asked to provide information on a survey-based questionnaire. The variables of this study were also previously investigated using quantitative data, which is necessary to analyze the relationship between variables. This study employed quantitative data, as previous studies in the nursing literature have also utilized quantitative instruments. In this study, data were collected through a rigorous methodology, targeting nursing students enrolled at multiple universities in Shanghai, China, as the study population. In this study, nursing students were selected for data collection, provided they had some experience in clinical practice. It was ensured that the students had an appropriate experience of clinical practice, and they were able to measure clinical performance.

This study used a purposive sampling method where the data were collected from the students based on the way they were available. The respondents were approached with informed consent, and the purpose of the study was explained to them. It was ensured that these students had appropriate knowledge about the nursing practices and agreed to provide the data. They were assured that their personal information would not be shared with any third party, but would be used solely for this study. The respondents agreed to provide the data, and a self-administered questionnaire was distributed to them. The questionnaire was based on two sections: demographics and Likert scale instruments. The demographic data was collected to understand the nature of the participants. At the same time, the Likert scale was adapted to collect data to measure the instruments of the study. The instruments used in this study are reported in Appendix A. To collect the data, this study distributed 500 questionnaires, assuming a maximum sample size of 300. However, a total of 317 responses were collected. During the preliminary analysis, this study removed the responses that were not reliable and outliers. The remaining sample of 305 responses was considered final for data analysis. This study used Partial Least Squares – Structural Equation Model (PLS-SEM) for the analysis of data. For this purpose, the software IBM SPSS 29 was used for demographics analysis, and Smart PLS 4 was used for inferential statistics.

RESULTS

The demographic profile highlights the characteristics of the study participants (see Table 1). The majority of respondents (69.84%) were pursuing a Bachelor's degree in Nursing, with smaller proportions holding a diploma (22.3%) or postgraduate qualification (7.87%). Most participants were young, with 60% aged 20–24 years, followed by 18.36% in the 25–29 age group. Only a small fraction were above 35 years (4.26%), indicating that the sample essentially represents early-career nursing students. In terms of clinical practice experience, nearly one-third (33.44%) had less than six months' exposure, while 29.84% reported six months to one year, suggesting that many were still in the early stages of practical training. Gender distribution was skewed towards females (81.31%), consistent with global nursing trends.

Regarding the institutional background, 41.97% were enrolled in public universities, followed by 31.48% in private universities. Fewer participants came from community colleges (17.38%) and nursing schools (9.18%). Access to the internet at clinical sites varied, though more than half (56.07%) always had access, while 29.84% sometimes had access, pointing to disparities in digital connectivity. Finally, technology familiarity was moderate among most respondents (39.67%), and study years were relatively balanced across cohorts, with the largest group in the third year (27.21%).

Table 1. Demographics Profile

Variable	Category	n	Percentage (%)
Academic Level	Bachelor's in Nursing	213	69.84
	Diploma in Nursing	68	22.3
	Postgraduate	24	7.87
Age	20–24	183	60
	25–29	56	18.36
	30–34	35	11.48
	35 and above	13	4.26
	Under 20	18	5.9

Clinical Practice Experience	1–2yr	62	20.33
	6mo–1yr	91	29.84
	<6 months	102	33.44
	>2yr	50	16.39
Gender	Female	248	81.31
	Male	57	18.69
Institution Type	Community College	53	17.38
	Nursing School	28	9.18
	Private University	96	31.48
	Public University	128	41.97
Internet Access at Clinical Site	Always	171	56.07
	Never	13	4.26
	Rarely	30	9.84
	Sometimes	91	29.84
Tech Familiarity	High	92	30.16
	Low	41	13.44
	Moderate	121	39.67
	Very High	39	12.79
	Very Low	12	3.93
Year of Study	1st Year	76	24.92
	2nd Year	77	25.25
	3rd Year	83	27.21
	Final Year	69	22.62

The findings of the measurement model assessment were used at the initial stage of PLS-SEM (see Figure 2). In the assessment of the measurement model, the study investigated the convergent validity first. The convergent validity was assessed using the findings of individual item reliability, which was checked with outer loadings. The findings of outer loadings above 0.70 are accepted as significant and acceptable (Hair et al., 2019). The study confirmed that all values for factor loadings were above the recommended threshold. Furthermore, the study tested the findings of average variance extracted to confirm the variance in the data. The findings of average variance extracted above 0.50 are considered significant, and all variables of this study achieved this threshold (Hair et al., 2019). Meanwhile, Cronbach's alpha and composite reliability were also tested in this study. The findings of both factors were above 0.70 for all variables (Hair et al., 2019). Hence, the reliability and validity of data were established, which is reported in Table 2.

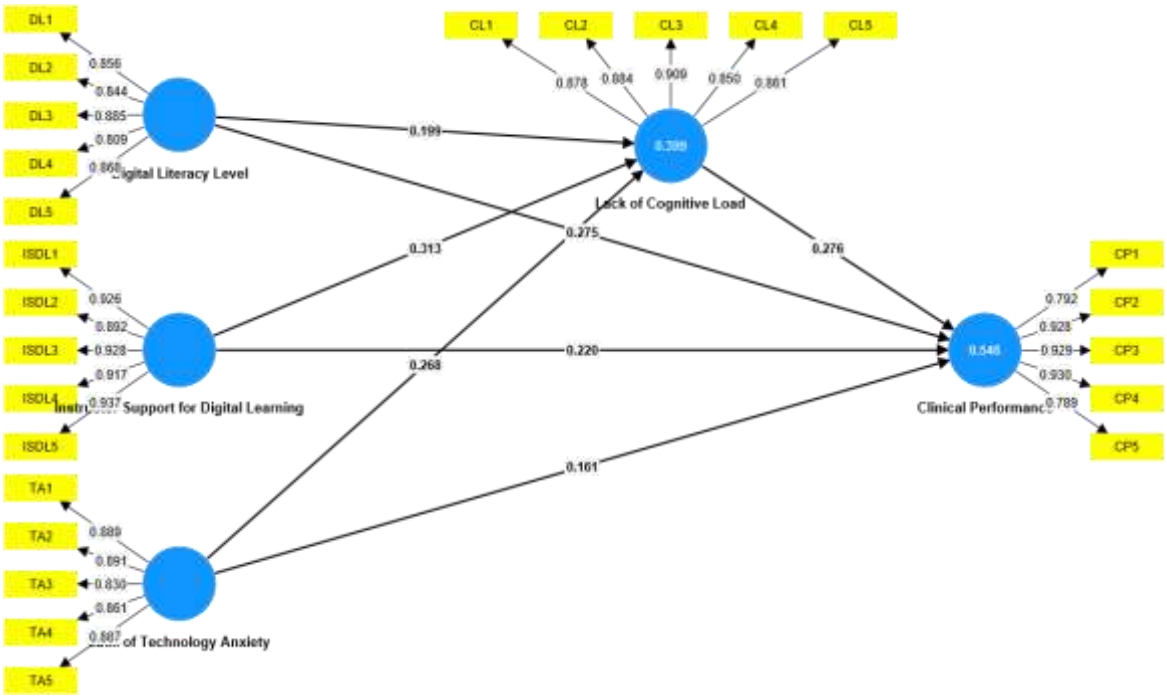

Figure 2. Measurement Model

Table 2. Convergent Validity

Variables	Items	Loadings	Cronbach's alpha	Composite reliability	Average variance extracted
Lack of Cognitive Load	CL1	0.878	0.925	0.943	0.769
	CL2	0.884			
	CL3	0.909			
	CL4	0.850			

	CL5	0.861			
Clinical Performance	CP1	0.792	0.923	0.943	0.768
	CP2	0.928			
	CP3	0.929			
	CP4	0.930			
	CP5	0.789			
Digital Literacy Level	DL1	0.856	0.906	0.930	0.728
	DL2	0.844			
	DL3	0.885			
	DL4	0.809			
	DL5	0.868			
Instructor Support for Digital Learning	ISDL1	0.926	0.955	0.965	0.847
	ISDL2	0.892			
	ISDL3	0.928			
	ISDL4	0.917			
	ISDL5	0.937			
Lack of Technology Anxiety	TA1	0.889	0.921	0.941	0.760
	TA2	0.891			
	TA3	0.830			
	TA4	0.861			
	TA5	0.887			

The study further tested the discriminant validity in the measurement model assessment. Heteritrait-Monotrait (HTMT) is a significant method to confirm the discriminant validity in the data. It confirms that the variables of the study have different data from one another, and the data do not overlap. Scholars recommended that an HTMT value less than 0.85 is significant to confirm no discriminant validity in the data (Henseler et al., 2015). The findings reported in Table 3 highlighted that discriminant validity was significantly achieved, as all HTMT values for all variables were less than 0.85.

Table 3. Discriminant Validity

Variables	Clinical Performance	Digital Literacy Level	Instructor Support for Digital Learning	Lack of Cognitive Load	Lack of Technology Anxiety
Clinical Performance	1.000				
Digital Literacy Level	0.647	1.000			
Instructor Support for Digital Learning	0.648	0.645	1.000		
Lack of Cognitive Load	0.656	0.523	0.590	1.000	
Lack of Technology Anxiety	0.530	0.383	0.492	0.520	1.000

In primary data collection studies, when a single source is used to collect the data, there can be multicollinearity in the data. The multicollinearity of data refers to the similarity of data and the collinearity of data for different variables. The study examined multicollinearity using the variance inflation factor (VIF), with findings ideally less than 3.3 (Hair et al., 2019). The assessment of VIF reported in Table 4 confirmed that all findings were less than 3.3. Hence, no multicollinearity issues were found in the data.

Table 4. Multicollinearity Assessment

Variables	**Clinical Performance**	**Lack of Cognitive Load**
Digital Literacy Level	1.649	1.584
Instructor Support for Digital Learning	1.925	1.762
Lack of Cognitive Load	1.665	-
Lack of Technology Anxiety	1.404	1.284

After the analysis of the measurement model, this study performed a structural model assessment test. In structural model assessment, the relationships between research variables were investigated (see Figure 3). For this purpose, scholars recommended that a t-value above 1.96 is necessary to accept the hypotheses with a probability level of 0.05 (Hair et al., 2019). Regarding H1, the study found that digital literacy level is positively associated with a lack of cognitive load. Furthermore, the study found that instructor support for digital learning is positively associated with a lack of cognitive load, confirming H2. Concerning H3, the study highlighted that a lack of technology anxiety is positively associated with a lack of cognitive load. Moreover, H4 is supported by evidence that digital literacy level is positively associated with clinical performance. The findings of H5 also confirmed that instructor support for digital learning is positively associated with clinical performance. Meanwhile, H6 reported that a lack of technology anxiety is positively associated with clinical performance. The findings of H7 reported that a lack of cognitive load is positively associated with clinical performance. The findings of direct paths are shown in Table 5.

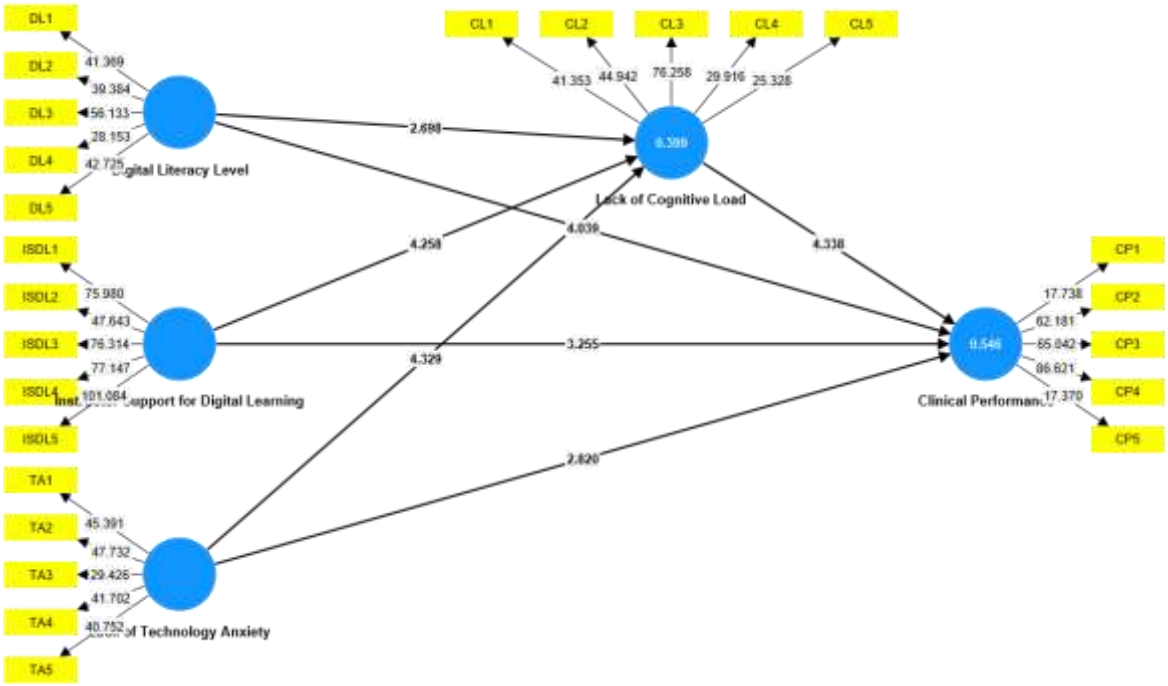

Figure 3. Structural Model

Table 5. Direct Path Findings

Paths	Original sample	Standard deviation	T statistics	P values
Digital Literacy Level -> Clinical Performance	0.275	0.068	4.039	0.000
Digital Literacy Level -> Lack of Cognitive Load	0.199	0.074	2.698	0.007
Instructor Support for Digital Learning -> Clinical Performance	0.220	0.068	3.255	0.001
Instructor Support for Digital Learning -> Lack of Cognitive Load	0.313	0.073	4.258	0.000
Lack of Cognitive Load -> Clinical Performance	0.276	0.064	4.338	0.000
Lack of Technology Anxiety -> Clinical Performance	0.161	0.057	2.820	0.005
Lack of Technology Anxiety -> Lack of Cognitive Load	0.268	0.062	4.329	0.000

The study further analyzed the relationship, and the findings are reported in Table 6. The findings of H8 reported that the lack of cognitive load mediates the relationship between digital literacy level and clinical performance. Moreover, the findings of H9 confirmed that the lack of cognitive load mediates the relationship between instructor support for digital learning and clinical performance. Finally, H10 results reported that the lack of cognitive load mediates the relationship between technology anxiety and clinical performance. The findings of indirect paths are reported in Table 6.

Table 6. Mediating Path Findings

Paths	**Original sample**	**Standard deviation**	**T statistics**	**P values**
Lack of Technology Anxiety -> Lack of Cognitive Load -> Clinical Performance	0.074	0.027	2.741	0.006
Digital Literacy Level -> Lack of Cognitive Load -> Clinical Performance	0.055	0.025	2.168	0.030
Instructor Support for Digital Learning -> Lack of Cognitive Load -> Clinical Performance	0.086	0.028	3.082	0.002

The study further analyzed the findings of the effect size (see Table 7). Effect size is assessed to check the effect of exogenous variables on endogenous variables. According to scholars, an effect size of 0.02 is small, 0.15 is medium, and 0.35 is large (Cohen, 1992). The findings of this study reported that the effect of digital literacy level is small on the lack of cognitive load and clinical performance. Furthermore, the study found that the effect of instructor support on digital learning is small, particularly in terms of reducing cognitive load and improving clinical performance. The study also found that the effect of a lack of cognitive control is small on clinical performance. The study also found that the effect of lack of technology anxiety is small on lack of cognitive load and clinical performance.

Table 7. Effect Size

Variables	**Clinical Performance**	**Lack of Cognitive Load**
Digital Literacy Level	0.101	0.042
Instructor Support for Digital Learning	0.055	0.092
Lack of Cognitive Load	0.100	-
Lack of Technology Anxiety	0.040	0.093

The findings of the coefficient of determination were also tested to understand the proportion of variables in the dependent variable based on the independent variables. Scholars recommended that an R2 value of 0.25 is weak, 0.50 is moderate, and 0.75 is substantial (Hair et al., 2019). The findings of R2 reported in this study confirmed that the lack of cognitive load is weak, but clinical performance achieved a moderate proportion from the independent variables. The findings of the coefficient of determination are reported in Table 8.

Table 8. Coefficient of Determination

Variables	R-square	R-square adjusted
Clinical Performance	0.546	0.540
Lack of Cognitive Load	0.399	0.393

Finally, the study assessed the findings of predictive relevance (see Figure 4 and Table 9). The findings of predictive relevance are used to assess the predictive power of the model. According to scholars, the value of predictive relevance (Q2) should be above 0, which confirms the model has significant predictive relevance (Hair et al., 2019). The findings of this study reported that Q2 was above the recommended threshold for lack of cognitive load and clinical performance. Hence, it was confirmed that the model has significant predictive power.

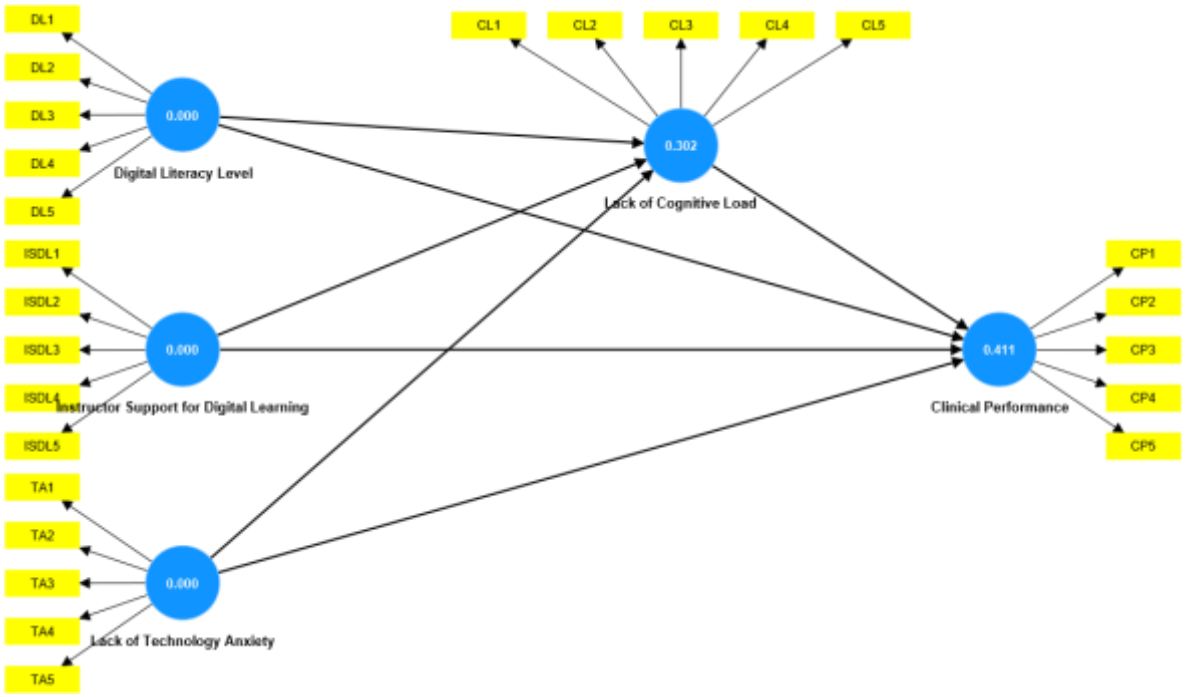

Figure 4. Predictive Relevance

Table 9. Predictive Relevance

Variable	SSO	SSE	Q^2 (=1-SSE/SSO)
Clinical Performance	1525.000	897.494	0.411
Digital Literacy Level	1525.000	1525.000	0.000
Instructor Support for Digital Learning	1525.000	1525.000	0.000
Lack of Cognitive Load	1525.000	1065.113	0.302
Lack of Technology Anxiety	1525.000	1525.000	0.000

DISCUSSIONS

In this study, all hypotheses were supported. Regarding H1, the study found that digital literacy level is positively associated with a lack of cognitive load. Previous studies, such as those by Peng and Yu (2022), also reported that high digital literacy levels reduce cognitive load on individuals. Another research, Skulmowski and Xu (2022), also provided similar findings that digital literacy helps the students to deal with critical challenges related to their performance. In the era of digital literacy, Rehman et al. (2024) reported that students should focus on learning digital technology that can help them shape their learning and performance more effectively. Although the previous studies supported this relationship, in the context of clinical performance of Chinese nursing students, the findings are novel.

Furthermore, the study found that instructor support for digital learning is positively associated with a lack of cognitive load, confirming H2. Susan (2023) highlighted that when the instructors provide appropriate support to the students regarding their digital learning, the performance of students is improved. At the same time, the study by Fooladi et al. (2022) emphasized that instructors provide appropriate mentorship to students regarding their learning of digital literacy, which can reduce the cognitive burden on them. At the same time, Imanipour et al. (2022) discussed how instructors' support

significantly shapes students' learning approach and digital literacy behavior.

Concerning H3, the study highlighted that a lack of technology anxiety is positively associated with a lack of cognitive load. The findings of this hypothesis are aligned with Ha and Lim (2023), who reported that a lack of anxiety about using technology can improve the digital learning of students, resulting in limited cognitive load. Furthermore, Tzafilkou et al. (2021) noted that reducing technology access can increase the workload of students, which should be minimized to control cognitive load. At the same time, the study by Na and Roh (2021) highlighted that students should be motivated to use technology that advances their behaviour for digital learning. However, in the context of Chinese nursing students, the findings are new in the discussion.

Moreover, H4 is supported by evidence that digital literacy level is positively associated with clinical performance. Giudice da Silva Cezar and Maçada (2021) also highlighted that when there is appropriate digital literacy, the clinical performance is reduced, resulting in productivity. Furthermore, Yeşilyurt and Vezne (2023) stated that advancements in digital literacy learning improve work performance. Meanwhile, Bahari (2023) pointed out that nursing staff should have information about digital literacy and the use of technology that results in shaping their workflow in better directions. Even though the relationship between digital literacy and performance has been discussed before, it is still new to the discussion in the context of clinical practice.

The findings of H5 also confirmed that instructor support for digital learning is positively associated with clinical performance. The findings are also aligned with those of Guerrero et al. (2021), who discussed how instructor support can shape student behavior and digital literacy levels. Furthermore, McVeigh et al. (2021) discussed that the clinical performance of nursing students is improved when they are appropriately trained for it by their instructors. Meanwhile, Arrogante et al. (2021) confirmed that reliable mentorship can improve the performance of clinical students. While existing studies support the findings, this study provides new insights into the knowledge.

Meanwhile, H6 reported that a lack of technology anxiety is positively associated with clinical performance. Hawes and Arya (2023) also emphasized that if there is no technological anxiety, the performance of nursing students is improved. The study by Zhao et al. (2023) stated that when clinical students are motivated to work, their way of working and direction are improved, which has a significant impact on their performance. At the same time, Yin et al. (2024) stated that when students have reasonable experience using modern technology, their understanding improves, which in turn shapes their behavior and learning for clinical performance.

The findings of H7 reported that a lack of cognitive load is positively associated with clinical performance. The study by Mauriz et al. (2021) stated that when there is limited cognitive load, the working performance of nursing students is increased. Another study, Kim and Shin (2021), also reported that limited cognitive burdens improve the performance of students, which is necessary for their appropriate behaviour and reasonable performance. While the study by Kang et al. (2021) stated that students with high motivation experience improved performance, as they have no cognitive load.

The findings of H8 reported that the lack of cognitive load mediates the relationship between digital literacy level and clinical performance. Even though this mediating relationship contributes new insights into the knowledge, a few previous studies support this relationship. The study by Berdida (2023) highlights that digital literacy is a significant factor in reducing cognitive load. At the same time, Chang et al. (2021) noted that a limited cognitive load is beneficial for students to enhance their clinical performance. Hence, the findings of this study are supported by previous research.

Moreover, the findings of H9 confirmed that the lack of cognitive load mediates the relationship between instructor support for digital learning and clinical performance. Although this mediating relationship is new, it has support from existing studies. Rogers and Franklin (2021) highlighted that when instructors play a significant role in students' learning, their cognitive load is reduced. On the other hand, Chen et al. (2022) stated that limited cognitive load is a significant and contributing factor for the clinical performance of the students. Therefore, the findings reported in this study are novel for the body of knowledge.

Finally, H10 results reported that lack of cognitive load mediates the relationship between lack of technology anxiety and clinical performance. This mediating relationship is new in the literature, but the previous studies support the findings. The study by Huai et al. (2024) stated that a lack of technology anxiety reduces the cognitive burden on people. Furthermore, Lapierre et al. (2022) noted that the lack of burden on students enhances their clinical performance. Hence, the findings of this study are significantly supported by existing studies, yet they are new to the existing knowledge base.

CONCLUSIONS

This study aims to respond to these challenges by empirically modeling digital literacy and instructor support for digital learning. To conclude, this study validates a coherent model in which digital literacy, instructor support for digital learning, and lack of technology anxiety exert direct, positive effects on lack of cognitive load and clinical performance. All hypothesized relationships were accepted, and the mediating role of cognitive load is clarified by the lack of cognitive load, which explains the mechanism by which learner competencies and instructional conditions translate into observable performance in clinical contexts. The results extend the traditions by demonstrating the concurrent operation within China's rapidly digitizing health education. The developed model in this study demonstrates how reductions in mental burden are not incidental but engineerable outcomes that amplify the returns on digital investment in students, thereby improving their clinical performance. From a novelty perspective, the findings suggest that digitally literate students, supported by instructors and experiencing a lack of technology anxiety, can allocate scarce cognitive resources to core tasks, yielding stronger clinical reasoning and safer practice. The study offers an integrated explanation of performance variation. It provides a practical blueprint, including cultivating digital literacy, institutionalizing instructor support, and systematically reducing anxiety to sustain a state of cognitive load that enables high-quality clinical performance in Chinese settings.

Theoretically, this study provides advances in knowledge in four ways and addresses potential gaps. Firstly, this study reframes reduced cognitive load as a positive engineerable state and places it as the proximal component linking digital literacy, instructor support for digital learning, and clinical performance. Therefore, it extends the knowledge to include variables such as technology anxiety and instructor support as part of the model. Secondly, this study connects these relationships to China as context, highlighting that this has been overlooked by scholars previously. Thirdly, this study provides operational definitions for anxiety reduction and cognitive load reduction and differentiates their possible role in the pipeline to performance. Fourthly, the study indicates that online learning has also given some evidence that competencies and the pedagogy students receive can affect performance more negatively through reduced cognitive load. Hence, the tested relationships in this study, including the mediating role of lack of cognitive load, are a new and significant contribution to the body of knowledge.

These findings of this study lead directly to actionable recommendations for universities, teaching hospitals, instructors, and vendors, all seeking to manage cognitive load in order to improve clinical performance. Firstly, this study highlights the need for baseline digital literacy diagnostics of incoming students, the provision of graduated micro-credentials in courses, and the integration of embedded opportunities to practice with the systems relied upon in placements over time. Secondly, this study provides information on faculty development in load-aware pedagogy-based segmentation, signaling, worked examples, pretraining, and just-in-time technical coaching to promote consistent instructor support for students. Thirdly, the study highlights the need to facilitate onboarding, low-stakes practice, peer support, and an in-system and simulation platform to help enable students to cope with technology anxiety. Fourthly, this study emphasizes considering usability and workflow fit as criteria for procurement decision-making, selecting interfaces with the least amount of gestural steps that can help students improve their clinical performance. To sum up, these steps make digital transformation a human-performance initiative rather than a technology deployment, producing more consistent clinical learning outcomes.

Although the findings of this research are novel in the literature, the study has some limitations that open a gate for further researchers. Initially, this study tested a model using quantitative data, which was based on self-administered structural questionnaires. Hence, the respondents had no option but to provide their subjective response to the questionnaires. Future studies are recommended to use mixed methodology, where data collected should provide significant insights both quantitatively and qualitatively. Second, this study focused solely on the context of China, where the population consisted of nursing students. Future studies should target other hotspots, such as demographics other than China, which can contribute significantly to the body of knowledge. In this way, the findings of this study would provide a significant and broader contribution to the body of knowledge.

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APPENDICES

Appendix A: Measurement Questionnaire

Variables	Item Statement
Digital Literacy Level	I can efficiently search for clinical information online.
	I am confident in using digital tools for clinical learning.
	I can evaluate the reliability of online nursing resources.
	I am comfortable using digital platforms for academic work.
	I can troubleshoot common technical issues on my own.
Instructor Support for Digital Learning	My instructors encourage the use of digital tools in clinical practice.
	I receive timely help from instructors when I face technical difficulties.
	Instructors integrate digital learning into clinical training effectively.
	My instructors provide clear instructions for using digital platforms.
	Instructors are open to using innovative technologies in teaching.
Lack of Technology Anxiety	I feel calm when starting a new digital tool required for learning.
	I feel relaxed using technology during clinical tasks.

	I remain at ease when a device or app behaves unexpectedly.
	I am comfortable exploring unfamiliar features in educational software.
	I am composed when troubleshooting basic technical issues.
	I am confident in handling updates or changes to digital platforms.
Lack of Cognitive Load	I can process digital learning content without feeling mentally strained.
	The digital tasks I do for clinical learning feel manageable in terms of mental effort.
	I rarely need to repeat steps to understand digital instructions.
	The layout of digital platforms makes it easy to find what I need with little effort.
	I can keep my attention on clinical content without feeling mentally fatigued.
	The amount of information presented at one time feels manageable.
Clinical Performance	I can apply theoretical knowledge effectively during clinical tasks.
	I make informed decisions using digital tools during clinical practice.
	I am confident in performing clinical procedures accurately.
	My clinical performance has improved with the help of digital learning.
	I can meet the clinical objectives set by my program.