

Beyond the PowerPoint Classroom: Nursing students' experiences of a TPACK-Informed learning environment

Aminath Rinzy¹, Sharifah Shafinaz Sh Abdullah^{2*}, Aminath Shafiya Adam³, Asma Saif Yahya Al-Hadabi⁴

** Corresponding author*

¹ PhD Candidate, Centre for Nursing Studies, Faculty of Health Sciences, UiTM Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia, ² Senior Lecturer, Teknologi MARA (UiTM), Centre for Nursing Studies, Faculty of Health Sciences, UiTM Puncak Alam Campus, 42300 Bandar Puncak Alam, Selangor, Malaysia, ³ Assistant Professor, Centre for Research and Publication, Islamic University of Maldives, ⁴ Nursing and Midwifery Tutor, College of Health Sciences, Oman College of Health Science, Sultanate of Oman

Aminath.rinzy@mnu.edu.mv, shasya@uitm.edu.my, aminath.shafiya@ium.edu.mv, asm39560@gmail.com
Tel: +60142391159

Abstract

A mixed-methods sequential explanatory study examined nursing students' experiences of a learning environment across three Maldivian nursing institutes. Aim to identify how TPACK-designed lessons redesign shaped students' learning experiences and to interpret these experiences through TPACK-in-context model. Paired outcome data (N=63) showed a significant score increase (73.46 to 88.70, $p < .001$). Followed by thematic analysis done with subsets of 26 students through focus group discussions and revealed alignment among content, pedagogy, and nursing content with a context-responsive learning environment. TPACK-informed teaching functions best as a context-responsive learning-environment redesign, extending TPACK-XK toward a proposed TPACK-N framework for nursing education.

Keywords: TPACK; Quality of life; Student Nurse; Lesson redesign

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1.0 Introduction

Republic of Maldives, a country situated within the broader regional educational domain of the Asia-Pacific and Indian Ocean, this study demonstrates how a global-level pedagogical framework is localised within the nursing education of a small island system, providing a tightly focused empirical window into the process of responsiveness of local regional institutions to trans-continental trend in educational technology. This study utilises the concept of the Technological Pedagogical Content Knowledge (TPACK) model to integrate technology through the interaction of technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK), together with TPK, TCK, PCK and the integrative TPACK domain (Koehler & Mishra, 2009; Mishra & Koehler, 2006). Petko, Mishra, and Koehler (2025) further expand on updating the TPACK model to emphasise that external context and Contextual Knowledge (XK) can shape educator practice. The educational environment informs TPACK, while XK covers educators' understanding of settings, technologies, policies, and learners.

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Received: 08 Jul 2026

Review Period: 06 Aug 2026 – 07 Sep 2026

Amended Accepted: 16 Sep 2026

Published: 23 Sep 2026

In nursing education, pedagogy to deliver lessons and technology that enhances teaching and learning must be integrated. In addition, the XK component connects theoretical knowledge with clinical reasoning, psychomotor performance, communication, professional values and patient safety and connects to the extended environment. Extending the literature, prospective nursing educators had stronger pedagogical and content knowledge than technology-integrated knowledge (Ait Ali et al., 2023). This is especially relevant in nursing, where various environments converge, making contextual awareness crucial for effective teaching. Stronger evidence from nurse educator studies identifies continuing development needs in digital pedagogy, safe and responsible technology use, and evidence-based guidance for learning (Pajari et al., 2024; Shon et al., 2024). In addition, heterogeneous digital competence profiles are associated with pedagogical preparation, experience and interest in educational technology (Pajari et al., 2025a, 2025b). This leads to context-sensitive digital competence.

The present paper asks how TPACK-informed lesson redesign can be understood as a redesign of the nursing learning environment and how students experience that environment. It integrates a concise quantitative outcome signal with the qualitative explanatory strand of a larger sequential explanatory mixed-methods study.

1.1 Aim and research question

The purpose of this explanatory sequential mixed-methods study is to first evaluate the effectiveness of TPACK-redesigned teaching on nursing students' learning by collecting gain scores from pre-test and post-intervention data from their assessment scores and then follow up with qualitative interviews to explain those statistical results by exploring the participants' detailed experiences following implementation of TPACK-designed teaching within the nursing educational environment.

1.2 The specific 3 objectives are to:

- (1) Quantitative phase: To measure the student learning outcome through their test score using their gain score.
- (2) Qualitative phase: To understand how students perceived the alignment of content, pedagogy, technology and clinical practice within that environment; describe nursing students' experiences within the redesigned, TPACK-informed learning environment.
- (3) Integration phase: Interpret the combined findings through the lens of an updated TPACK-in contextual model integrating Educators's contextual knowledge (XK).

2.0 Literature Review

2.1 Theoretical Foundations: TPACK in Nursing Student Learning Environments

The design of effective student learning environments in nursing education requires a multifaceted synthesis of theoretical knowledge, psychomotor skill acquisition and clinical decision-making. Historically, technology integration in healthcare education was considered an auxiliary media delivery tool which was often isolated from core instructional design. In order to address this limitation, Mishra and Koehler (2006) proposed the Technological Pedagogical Content Knowledge (TPACK) framework and thus expanded Shulman's pedagogical content knowledge to demonstrate how technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) dynamically intersect (Koehler & Mishra, 2009). In comparison, in nursing student learning environments, foundational TPACK literature establishes that digital tools cannot enhance learning outcomes on their own but depend on educational efficacy and pedagogical alignment with complex clinical content and real-world care scenarios (Koehler & Mishra, 2009; Mishra & Koehler, 2006).

As Figure 1 shows, the conceptual application retains the integrity of Petko et al. (2025) updated framework, in which external context is not treated as an eighth knowledge domain. Rather, the external nursing educational context shapes the development and enactment of TPACK, while XK represents the educator's knowledge about that environment. Hence, this paper focuses on external context, which includes curriculum, learner characteristics, accessibility, classroom and skills-laboratory conditions, clinical expectations and available technologies. XK includes educators' understanding of these conditions and their capacity to use that understanding when aligning technology, pedagogy and nursing content.

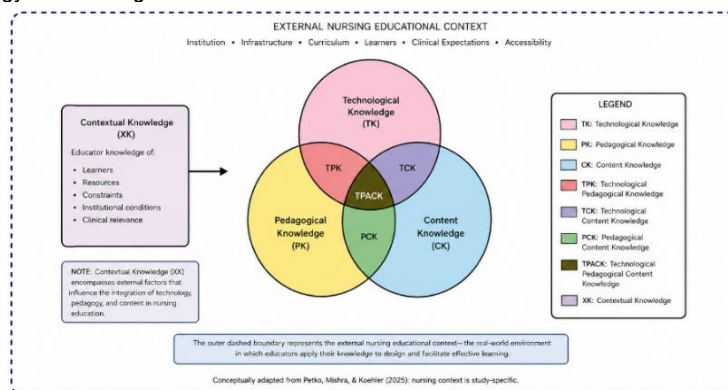


Figure 1 Conceptual application of the updated TPACK-in-context model to the nursing educational environment
Source: Original study-specific schematic informed by Petko, Mishra, and Koehler (2025); it is not a reproduction of their published figure.

2.2 Digital Learning Modalities and Student Outcomes in Nursing Environments

There is a rapid evolution of technology-enhanced learning environments incorporating extended reality (XR), virtual reality (VR) simulations, serious gaming, and interactive digital platforms that have fundamentally altered nursing pedagogy (Byrne, 2026; Choi et al., 2022; Plotzky et al., 2021). A robust body of contemporary synthesis and empirical research confirms that technology-integrated learning environments significantly improve knowledge acquisition, clinical reasoning, psychomotor performance and engagement of nursing students (Kim & Shin, 2023; Li et al., 2024; Min et al., 2022; Mulyadi et al., 2021; Özdemir & Dinç, 2022; Tavares, 2022; Woon et al., 2021). Immersive VR and simulation environments provide student nurses with safe, low-anxiety spaces to practice high-stakes clinical decision-making without risking patient safety (Kim & Shin, 2023; Mulyadi et al., 2021; Tavares, 2022). However, recent systematic reviews emphasise that high-tech environments do not automatically provide superior learning gains; educational success depends on how effectively digital modalities are embedded in active learning strategies, authentic clinical contexts and structured debriefing (Choi et al., 2022; Li et al., 2024).

2.3 Educator TPACK, Contextual Knowledge (XK), and Environmental Optimisation Digital Learning Modalities and Student Outcomes in Nursing Environments

Optimising the student learning environment also depends on the digital and pedagogical competence of nurse educators. From a global perspective, empirical studies demonstrate that while faculty possess advanced clinical expertise and strong pedagogical grounding, their skills in integrating technology are a significant area for growth (Ait Ali et al., 2023; Pajari et al., 2024, 2025a, 2025b). Addressing this gap requires targeted, TPACK-based faculty development programs that empower educators to effectively scaffold learning across physical classrooms, simulation laboratories and clinical practice placements (Pajari et al., 2024; Shon et al., 2024). Furthermore, Petko et al. (2025) expanded the classic framework to incorporate Contextual Knowledge (XK) explicitly, acknowledging that learning environments are constrained and shaped by institutional infrastructure, clinical practice norms and evolving learner fluencies across generational cohorts (Höfrová et al., 2024). Applying XK within TPACK enables nurse educators to dynamically adapt instructional technology to specific environmental constraints and clinical safety guidelines, transforming digital spaces into responsive, high-impact nursing learning environments (Grünleitner et al., 2026; Petko et al., 2025).

3.0 Methods

3.1 Design and setting

This paper reports the student-focused explanatory component of a larger sequential explanatory mixed-methods study conducted in nursing education in the Maldives. The broader study developed and implemented a TPACK teaching module for nurse educators in the Maldives. This student-focused study was conducted as part of the larger parent TPACK teaching-module study, which received ethical approval from the Universiti Teknologi MARA Research Ethics Committee, Malaysia (REC/06/2025/PG/MR/332), and the Research Development Office of The Maldives National University (RC/2026/ATCRMNU/01). Written informed consent was obtained from all participants, with confidentiality, anonymity, voluntary participation and the right to withdraw maintained throughout the study. For the present paper, quantitative findings are intentionally limited to a concise outcome signal and integrated only with the subsequent qualitative strand of students. A separate manuscript reports the detailed quantitative analysis of student outcomes; the present paper's distinct contribution is the TPACK-in-context conceptualisation and mixed-methods interpretation of the nursing learning environment.

This paper presents the student-focused explanatory component of a larger sequential explanatory mixed-methods study evaluating a TPACK teaching module for nurse educators in the Maldives. Quantitative learning outcomes were obtained from 63 students enrolled in classes taught by nurse educators who implemented the TPACK-informed intervention. Student performance was assessed before and after the nurse educators applied the TPACK-informed teaching approach, allowing pre-intervention and post-intervention learning outcomes to be compared. Of these 63 students, a subset of 26 students was subsequently selected to participate in focus group discussions to explore their experiences of the learning environment before and after implementation. Focus group discussions continued until data saturation was reached. The paper integrates the quantitative pre-post outcome findings with the qualitative experiences of this student subset to interpret the TPACK-informed nursing learning environment.

The researchers did not allocate students to an intervention; rather, the student sample comprised learners who received teaching from nurse educators who implemented the TPACK-informed teaching approach in their respective lessons. The semester teaching remained under the responsibility of the students' respective nurse educators, thereby allowing the intervention to be implemented within the authentic teaching and learning environment.

3.2 TPACK-informed educational intervention

Nurse educators received structured preparation in TPACK and redesigned existing lessons by aligning learning objectives, nursing content, pedagogical strategies, educational technologies, student learning activities and assessment. The intervention did not prescribe a single technology. Instead, educators selected technologies based on pedagogical purpose, content, and contextual requirements. Students therefore experienced TPACK indirectly through redesigned teaching rather than receiving instruction about TPACK itself.

3.3 Quantitative Component

Paired learning-outcome data were available for 63 nursing students across various programmes: Master's (n=10, 15.9%), degree (n=17, 27.0%), diploma (n=21, 33.3%), and advanced-certificate (n=15, 23.8%). Pre-intervention scores were approximately normal (Shapiro-Wilk $W=.971$, $p=.148$), as were gain scores ($W=.970$, $p=.134$). A paired-samples t test was utilised for pre/post comparison. The pre-intervention assessment was conducted by the respective nurse educator, followed by a post-intervention assessment after implementing the TPACK-informed approach. Learning improvement was measured by the difference between pre- and post-test scores. Assessments were developed by educators and should be interpreted as indicators of lesson-specific learning performance. Gain scores were included to evaluate the impact of TPACK design on individual student learning improvement.

3.4 Qualitative component

Participants for the qualitative study were selected from 63 students who took part in a TPACK-informed teaching intervention by their nurse educators. With informed consent, students eligible for focus groups attended sessions before and after TPACK integration, allowing them to reflect on their learning. A total of four focus groups were held, involving 26 students (identified as ST01–ST26). Two researchers independently coded the transcripts using an inductive thematic approach, comparing their codes and discussing discrepancies to reach consensus. Data collection continued until saturation had been achieved in order to capture insights into the students' experiences with the intervention. The analysis was concerned with aligning student experiences with the intervention. Throughout the study, participants were assured that their feedback would not impact their academic performance or relationships with educators and that they were encouraged to share their experiences. In order to establish credibility, each participant was given a unique identification code for anonymity, and a moderator documented the discussions; transcripts were kept as part of an audit trail. Member checking was performed for accuracy before analysis, and independent coding improved the consistency and reliability of the findings.

3.5 Mixed-method integration

Integration occurred at interpretation. The quantitative strand established the direction and magnitude of change, while the qualitative strand explained how students experienced the redesigned learning environment.

4. Results

4.1 Concise quantitative outcome

Student scores presented in Table 1 increased substantially following implementation. As seen in the paired scores for the 63 students, both the intervention and control groups have a mean increase in knowledge gain score of +15.24, with a p -value indicating significance. The quantitative evaluation confirms that the redesigned, TPACK-informed learning environment produced significant learning gains across all academic tiers (n=63), including diploma (n=21,33.3%), degree (n=17,27.0%), advanced-certificate (n=15,23.8%), and Master's (n=10,15.9%) programs. Normality assumptions were satisfied for both pre-intervention scores ($W=.971$, $p=.148$) and gain scores ($W=.970$, $p=.134$), confirming the parametric reliability of the paired-samples t -test comparisons.

Table 1. Key quantitative outcome used for mixed-method integration

Outcome	Pre-intervention	Post-intervention	Mean change	Paired comparison
Student score (N=63)	73.46 (SD 7.09)	88.70 (SD 7.49)	+15.24	$t(62)=-33.60$, $p<.001$

4.2 Student experiences of the TPACK-informed learning environment

Students share their experiences, which are tabulated into five main themes. As indicated, Table 2 presents the qualitative themes interpreted from their FGD, presented in sub-themes from 4.2.1 to 4.2.5. The highlighted quotations are strong verbatim quotes from students that were supportive and will be discussed further.

Table 2. Qualitative themes are interpreted through TPACK-in-context.

Theme	Interpretive focus	Illustrative evidence	TPACK-in-context link
Meaningful alignment and authenticity	Resources; objectives, content-assessment alignment; academic and nursing relevance	Students identified stronger learning when resources and activities matched expected learning and practice.	CK-PK-TK decisions respond to disciplinary and clinical context.
Active, visual and experiential learning	Visual aids, demonstrations, interaction and experiential strategies	Students preferred approaches that helped them see, discuss, practice and connect concepts, not just teach from PowerPoint presentations.	Technology gains value through purposeful pedagogical alignment.
TPACK-integrated teaching enhanced interaction and learning	Purposeful technology integration; engagement; peer-supported participation	"I like when the teacher integrates technology in class." (ST13)	Technology is positive when it supports pedagogy, participation and content understanding.
Integration of content, pedagogy and technology	Selection of digital tools according to learning purpose	"Bio digital apps." (ST22); "Teach using technology effectively." (ST24)	Reflects integrated rather than technology-only logic.
Supportive, well-organised learning environments	Digital expectations, generational differences, flexible learning needs	"Sometimes we teach them how to do stuff." (ST26); "Age gap	XK includes learner practices, roles, resources and constraints.

perspective is there but can manage well now." (ST25)

4.2.1 Meaningful alignment and authenticity

Students' accounts emphasised coherence among what was taught, how it was taught, what resources were used, how learning was assessed and how classroom learning related to nursing practice.

4.2.2 Active, visual and experiential learning

Students valued active and visual approaches that supported understanding and participation. Their accounts indicated that engagement was linked to pedagogy and learning activity, not simply to the presence of a digital device or platform.

4.2.3 TPACK-integrated teaching enhanced interaction and learning

Student ST13 stated, "I like when teachers integrate technology in class." The significance reflects the integration of educational technologies.

4.2.4 Integration of content, pedagogy and technology

Students identified specific digital possibilities, including "Bio digital apps" (ST22), while also articulating the need to "Teach using technology effectively" (ST24).

4.2.5 Supportive and context-responsive learning environments

The data also revealed changing educator–student technology relationships. ST26 observed, "Sometimes we teach them how to do stuff," while ST25 noted that an "Age gap perspective is there but can manage well now." These accounts are particularly relevant to XK because they concern educators' knowledge of learners, digital practices and contextual differences.

4.3 Mixed-method integration

As shown in Figure 2, the quantitative strand showed a clear upward outcome pattern, while the qualitative strand explained features of the learning environment surrounding that pattern. The convergence was not interpreted as evidence that 'more technology causes better scores'. Rather, students' accounts point to purposeful alignment, interaction, visual/experience learning and contextual responsiveness as plausible educational mechanisms. The integrated inference is that TPACK-informed lesson redesign may support learning by improving the coherence of the learning environment in which technology is used.

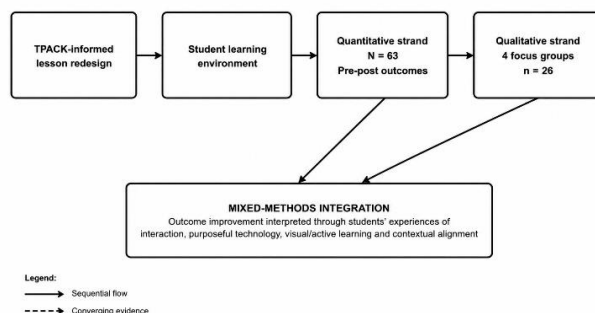


Figure 2. Explanatory integration of quantitative outcomes and student learning environment experiences.

5. Discussion

The principal contribution of this paper is conceptual rather than a second quantitative report on effectiveness. The findings demonstrate how the updated TPACK-in-context model can be applied to nursing education by positioning technology integration within an external educational context and distinguishing that context from educators' knowledge about it. Nursing educators make technology decisions under conditions shaped by infrastructure, curricula, student characteristics, accessibility, clinical relevance and institutional support. The concise quantitative signal showed substantial improvement in student scores. However, the qualitative findings caution against attributing benefit to technology alone. Students (ST) value interaction, visualisation, active participation, alignment, and effective use.

5.1 Quantitative Phase: Evaluating Student Outcomes in the Redesigned Environment (Objective 1).

The gain score was significant, resulting in a positive learning outcome. These quantitative results provide empirical evidence that students across diverse baseline levels responded positively to the redesigned environment. However, students' demographics or other factors that could influence their learning during the intervention may also play a role.

5.2 Qualitative Phase: Student Perceptions of Content, Pedagogy, Technology, and Nursing Education Alignment (Objective 2)

The qualitative findings provide deeper context for the quantitative gains by illustrating how nursing students experienced the alignment of content, pedagogy, technology and clinical practice. Students discussed apps and device assistance, such as using "Bio digital apps" (ST22), which allowed learners to visualise, discuss and apply complex clinical concepts aligned to course objectives and real-world clinical practice rather than introduced as isolated tools. This pattern is found in the literature with broad nursing-education evidence that well-designed simulation, virtual reality, game-based, and other digital methods can improve learning outcomes (Mulyadi et al., 2021; Woon et al., 2021; Plotzky et al., 2021; Min et al., 2022; Tavares, 2022). This highlights that technology added substantial educational value only when embedded in active pedagogy: "I like when teacher integrate technology in class" (ST13), "Teach using technology effectively" (ST24). These accounts demonstrate that nursing students view technology tools as tools that are not independent drivers of learning, but rather amplify pedagogical clarity and clinical relevance when seamlessly integrated into instructional design in the Maldives.

5.3 Integration phase: Interpret the combined findings through the lens of the updated TPACK-in-context model, explicitly separating external contextual factors from the educators' Contextual Knowledge (XK) (Objective 3).

Integrating the quantitative and qualitative findings through the updated TPACK-in-context framework (Objective 1.2.3) demonstrates that measurable learning gains rely on the interaction between external environmental conditions and educators' internal Contextual Knowledge (XK). To apply the model accurately, external contextual factors, including institutional and technological infrastructure (e.g. 3D anatomy apps and curriculum schedules), learner demographics that span across a spectrum of academic tiers, and high-stakes clinical practice demands, must be decoupled from XK, which represents the educator's cognitive ability to respond to these variables. The integrated qualitative evidence shows that faculty utilises XK to bridge generational gaps, acknowledging that an "age gap perspective is there", but that strategies allow them to "manage well now" (ST25). Furthermore, the presence of strong XK enables educators to reconfigure traditional classroom hierarchies by leveraging student digital fluencies ("sometimes we teach them how to do stuff" [ST26]) and choosing context-appropriate tools aligned to physical spaces and clinical constraints. While the external factors set the structure of the redesigned learning environment, it is the educator's Contextual Knowledge that determines how TPACK decisions are applied to enhance student learning outcomes. This distinction aids interpretation of the title 'Beyond the PowerPoint Classroom'. The Maldivian classroom teaching of presentation on screen is inherently ineffective, but replacing one delivery medium with another without reconsidering pedagogy, content, learner activity and assessment is not likely to represent a meaningful digital transformation. TPACK offers a framework for redesigning these relationships. The findings correspond with recent nurse-educator research. Ait Ali et al. (2023) found that prospective nursing educators indicated comparatively greater difficulty in integrating technology with pedagogy and content. Pajari et al. (2024) identified evidence-informed guidance, safe and responsible technology use and appropriate learning design as core dimensions of nurse-educator digital competence. Shon et al. (2024) similarly demonstrated the value of faculty development that addresses pedagogy, digital resources, teaching strategies, assessment, and learner empowerment (Pajari et al., 2025a, 2025b). The student accounts add another layer; learners are part of the context. Educational nursing-related technology support illustrates the capacity for expertise to flow both ways between educators and students. In a TPACK-in-context framework, understanding how students engage with technology contributes to knowledge expansion (XK). This is essential in nursing, where digital fluency must be integrated with evidence appraisal, clinical judgement, communication, ethics, and human-centred care. Incorporating this XK improves student learning and education quality, ultimately leading to an enhanced future of nursing and quality of life in the Maldives.

6. Conclusion and Recommendations

The updated TPACK-in-context model provides a useful lens for understanding technology integration as nursing learning-environment design. A substantial improvement in student scores was accompanied by qualitative accounts emphasising alignment, active and visual learning, purposeful technology integration, interaction and contextual responsiveness. Distinguishing external context from Contextual Knowledge clarifies why effective digital teaching requires more than technological skill: educators must understand the learners, resources, constraints and clinical expectations within which technology, pedagogy and nursing content are combined. The resulting conceptual application positions TPACK-informed teaching as a context-responsive redesign of the nursing learning environment.

The limitation of this study is that student outcome components used a pre/post design without a parallel student control group, so improvement cannot be attributed exclusively to TPACK-informed teaching. Student learning outcomes were based on lesson-specific pre-intervention and post-intervention assessments developed and administered by the nurse educators responsible for the respective lessons. Although these assessments provided a pragmatic measure of changes in student performance, they could be improved by moderating the tests given to students to enhance validity. The study was conducted in the Maldivian nursing-education context, and transferability should consider differences in infrastructure, curricula and institutional conditions. The qualitative findings represent participating students' experiences. Generation Alpha was not sampled; its discussion is prospective only; therefore, it is recommended to improve research findings using a pre/post design without a parallel student control group for a stronger methodological approach. As the first Gen Alpha generation of students would be entering higher education in 2028, future studies need to determine the educational technological pedagogies which can be embedded into their learning needs.

Acknowledgements

The authors acknowledge the support of the Centre for Nursing Studies, Faculty of Health Sciences, Puncak Alam, Universiti Teknologi MARA (UiTM). In addition, they acknowledge the institutional support of The Maldives National University (MNU). This study is not funded by any organisation or body. In addition, the authors acknowledge the support of all the co-authors of this paper.

Paper Contribution to Related Field of Study

This paper contributes to the nursing learning environment as an academic environment–behaviour system in which external context and educators' Contextual Knowledge (XK) jointly shape technology-integrated teaching. Building on this application, the paper proposes TPACK-N (a framework focused on the Nursing Discipline), offering nurse educators, curriculum designers and faculty developers a discipline-relevant lens for aligning nursing content, pedagogy, technology, learner needs and clinical context. The findings inform faculty development priorities and learning-environment evaluation practices for technology-enhanced nursing education, and provide an empirical, context-responsive counterpoint to research that attributes learning gains to technology adoption alone. Therefore, by strengthening context-responsive, technology-integrated nursing education, TPACK-informed teaching may help prepare more competent and adaptable nurses, supporting safer patient care and, ultimately, improved quality of life for individuals and communities.

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