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A Novel Integrated Nursing Ecosystem for Undergraduate Community Education: Development and Empirical Grounding of the Pitsachart Integrated Community–Virtual Living Nursing Model (PICVL-NM)

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ABSTRACT: Background: Undergraduate nursing education must prepare graduates for complex community-based practice environments, yet curricula remain predominantly oriented to hospital placements and simulation laboratories. Existing frameworks seldom integrate caring science, service quality measurement, digital health infrastructure, community co-creation and sustainability within a single educational ecosystem.

Objective: To develop and conceptualize the Pitsachart Integrated Community–Virtual Living Nursing Model (PICVL-NM) as an integrated ecosystem architecture for undergraduate community nursing education, and to empirically ground the model within a community-based Virtual Living Laboratory (VLL) rotation in Thailand.

Methods: A theory-development design with empirical grounding was employed. Conceptual synthesis integrated six core domains: Watson’s caring science, SERVQUAL-based service quality intelligence, joint venture community co-creation, VLL infrastructure, holistic nursing and the Sustainable Development Goals (SDGs). Empirical data derived from a convergent mixed-methods study in a Thai community VLL, involving 166 participants (patients $n = 10$; family caregivers $n = 24$; undergraduate nursing students $n = 132$). Quantitative data were collected using a validated, adapted SERVQUAL instrument (Cronbach’s $\alpha = 0.92$), and qualitative data through semi-structured interviews analyzed using reflexive thematic analysis and joint display integration.

Results: The PICVL-NM was structured as a four-domain ecosystem architecture comprising theoretical foundations, VLL-based operational processes, measurable outputs and long-term outcomes. Satisfaction was high across stakeholder groups (mean = 4.06–4.17 on a five-point scale), with responsiveness and empathy rated very highly, while tangibles were moderately high but constrained by home environments and digital resources. Overall, 87.1% of students reported increased confidence in assessment, communication and home-based care. Thematic analysis identified three core themes:

Accessibility and Responsiveness, Empathy and Trust-Building, and Community Co-Creation.

Conclusion: The PICVL-NM offers a novel, empirically grounded ecosystem architecture for undergraduate community nursing education, linking VLL-based community rotations with service quality, student competency and community engagement. The framework is scalable and adaptable across curricula and community health system contexts.

1. INTRODUCTION

Global health systems are undergoing a profound transformation driven by population ageing, the rising burden of non-communicable diseases, and increasing demand for equitable and sustainable care. The World Health Organization has emphasized the urgent need to shift from hospital-centric models toward community-based, person-centered and integrated care systems to achieve universal health coverage and long-term sustainability (WHO, 2023; WHO, 2021). Within this context, home-based and community-embedded nursing have emerged as critical strategies for improving access, continuity of care and health equity.

Despite this shift, undergraduate nursing education remains predominantly oriented to hospital-based clinical placements and campus simulation laboratories. Although these environments develop foundational technical skills Kijsomporn et al. (2024), they are insufficient to prepare students for the relational complexity, contextual adaptability and continuity demands characteristic of community practice (Benner et al., 2010; Polit & Beck, 2021). Service-learning, community placements and living laboratory models have been introduced to address this gap; however, these approaches frequently operate in isolation and lack integration with broader theoretical, digital and system-level frameworks (Leminen, 2015; Pombo et al., 2020).

Simultaneously, several theoretical and practical resources exist that are directly relevant to community nursing education. Watson's caring science provides a foundational ethical and relational framework (Watson, 2021). The SERVQUAL model offers a validated, multi-dimensional approach to measuring service quality and satisfaction (Parasuraman et al., 1988; Babakus & Mangold, 1992). Digital health innovations—including telemedicine, tele monitoring and smart home technologies—have expanded access and care efficiency (Topol, 2019; Keesara et al., 2020; Wider et al., 2024). Community co-creation and partnership models enhance stakeholder engagement and sustainability (Osborne et al., 2016; Bovaird, 2007). However, these domains are typically applied in isolation. No unified educational architecture has yet systematically integrated caring science, service quality, digital infrastructure, community co-creation and sustainability into a coherent, operational nursing education ecosystem. This fragmentation limits both the theoretical advancement of community nursing education and its practical implementation.

From a systems perspective, healthcare functions as a complex adaptive system that requires dynamic interactions, feedback mechanisms and multi-level integration (von Bertalanffy, 1968; Meadows, 2008; Sterman, 2000). These principles are insufficiently addressed in conventional linear nursing education frameworks, which separate theoretical learning from clinical practice and community engagement.

To address this gap, this study introduces the Pitschart Integrated Community–Virtual Living Nursing Model (PICVL-NM): a novel integrated nursing ecosystem architecture that synthesizes six foundational domains—human caring, service quality intelligence, community co-creation, virtual living laboratory infrastructure, holistic nursing and sustainability governance—within a community-based VLL rotation for undergraduate nursing students. The aims were to: (1) develop and conceptualize the PICVL-NM as an integrated educational ecosystem architecture; (2) define its structural components and dynamic interactions across theory, practice and outcomes; and (3) empirically ground the model using convergent mixed-methods evidence from patients, caregivers and nursing students in a VLL programme.

2. CONCEPTUAL FRAMEWORK

The PICVL-NM is conceptualized as a dynamic, integrated nursing ecosystem architecture that links theoretical foundations, VLL-based operational processes, measurable educational and service outputs, and long-term system outcomes within a continuous adaptive feedback system. Unlike conventional linear frameworks, the PICVL-NM treats nursing education as a

complex adaptive ecosystem in which theoretical constructs, clinical processes and outcomes co-evolve through structured feedback loops.

The model integrates six complementary theoretical domains into a unified architecture:

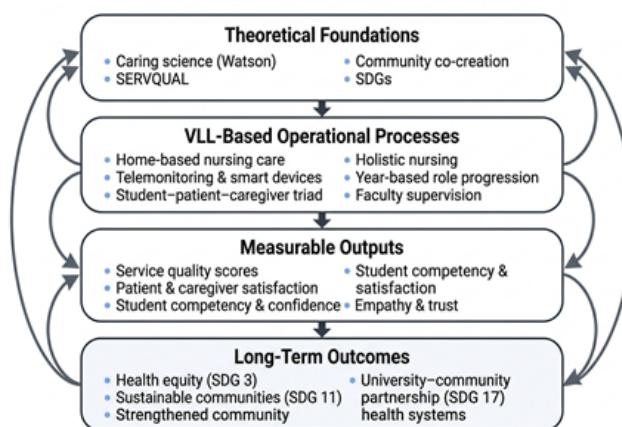
1. **Human Caring** – Watson's transpersonal caring science provides the ethical and relational core, emphasizing empathy, trust and authentic presence as both educational values and care outcomes (Watson, 2021).
2. **Service Quality Intelligence** – The SERVQUAL framework operationalizes quality measurement across five dimensions (tangibles, reliability, responsiveness, assurance and empathy), providing empirical evidence for educational refinement (Parasuraman et al., 1988).
3. **Community Co-Creation (Joint Venture Learning)** – A joint venture model of learning embeds students as active partners with community stakeholders, enabling shared ownership of care processes and educational outcomes (Osborne et al., 2016; Bovaird, 2007).
4. **Virtual Living Laboratory Infrastructure** – The VLL provides a digitally augmented, real-world learning environment in community households, incorporating tele monitoring and smart devices to support home-based nursing (Leminen, 2015; Pombo et al., 2020).
5. **Holistic Nursing** – Holistic practice principles guide integration of physical, psychological, social and spiritual care, preparing students for person-centered community engagement (Dossey et al., 2016).
6. **Sustainability and the SDGs** – Alignment with Sustainable Development Goals—particularly SDG 3 (good health and well-being), SDG 11 (sustainable communities) and SDG 17 (partnerships)—positions the model within global health priorities (United Nations, 2023).

The framework is organized into four interdependent domains. **Theoretical foundations** constitute the knowledge base of the ecosystem. **Operational processes** include VLL-based home nursing care, tele monitoring, student–patient–caregiver triadic interaction, year-based role progression, reflective learning, faculty supervision and community co-design. **Measurable outputs** encompass service quality scores, patient and caregiver satisfaction, nursing student competency, confidence and qualitative experiential dimensions (empathy, trust, and accessibility). **Long-term outcomes** include health equity (SDG 3), sustainable communities (SDG 11), multi-stakeholder partnership (SDG 17), strengthened community health systems and sustainable university–community partnerships.

A dynamic feedback loop connects all four domains: empirical evidence continuously informs theoretical refinement and process optimization, transforming the PICVL-NM into a "living ecosystem" characterized by continuous learning and co-evolution of stakeholders.

Figure 1. The Pitsachart Integrated Community–Virtual Living Nursing Model (PICVL-NM): an ecosystem architecture linking theoretical foundations, VLL-based operational processes, measurable outputs and long-term outcomes through continuous feedback loops.

Pitsachart Integrated Community–Virtual Living Nursing Model (PICVL-NM)



The Pitsachart Integrated Community–Virtual Living Nursing Model (PICVL-NM) conceptualizes undergraduate community nursing education as an ecosystem comprising four interdependent domains—Theoretical Foundations, VLL-Based Operational Processes, Measurable Outputs and Long-Term Outcomes—linked by continuous feedback loops. The model integrates caring science, service quality intelligence, community co-creation, holistic nursing, digital VLL infrastructure and sustainability (SDGs) to connect home-based learning processes with service quality, student competency and community-level outcomes such as health equity, sustainable communities and university–community partnerships.

3. METHODS

3.1 Study Design

A theory-development design with empirical grounding was employed. The design combined: (i) conceptual integration of multiple theoretical domains through a systems-based synthesis process; and (ii) empirical validation derived from a convergent mixed-methods study conducted in a community-based VLL (Creswell & Plano Clark, 2018). This approach ensured both theoretical rigor and real-world applicability of the resulting model.

3.2 Conceptual Integration Process

Model development followed a four-stage integrative process informed by integrative theoretical development principles (Meadows, 2008; Sterman, 2000):

Stage 1 – Identification of core theoretical domains: A structured review of nursing, health systems and digital health literature identified six domains relevant to community nursing education: human caring (Watson, 2021); service quality (Parasuraman et al., 1988); community co-creation (Osborne et al., 2016); VLL and digital health infrastructure (Leminen, 2015; Pombo et al., 2020); holistic nursing (Dossey et al., 2016); and sustainability (United Nations, 2023).

Stage 2 – Conceptual mapping and synthesis: The six domains were systematically mapped using a systems-thinking approach, enabling identification of relationships across theoretical constructs, operational processes and outcome pathways, guided by general systems theory (von Bertalanffy, 1968).

Stage 3 – Structural model construction: The PICVL-NM was constructed as a multi-layer ecosystem architecture, organized into four interdependent domains and linked through adaptive feedback mechanisms (see Section 2).

Stage 4 – Empirical grounding: Empirical findings from the VLL study were used to validate, refine and operationalize the model's structural components and outcome pathways.

3.3 Setting and Educational Context

The empirical component of the study was conducted within a community-based Virtual Living Laboratory established by the Faculty of Nursing, Shinawatra University, Thailand. The VLL functioned as a structured living classroom embedded in real

community households receiving home nursing services. It operated as a joint venture between the university and local communities, with structured year-based role assignments for nursing students across the undergraduate programme.

3.4 Participants

Three stakeholder groups participated in the convergent mixed-methods study: (1) patients receiving home nursing care through the VLL; (2) their primary family caregivers; and (3) undergraduate nursing students undertaking a community rotation. Eligible patients were community-dwelling adults with chronic or long-term care needs who had received at least one month of VLL home visits, were able to communicate in Thai and provided informed consent; those with severe cognitive impairment were excluded. Caregivers were adults providing unpaid care in the same household. Students were enrolled in years 2–4 of the four-year Bachelor of Nursing Science programme and had completed at least one semester of clinical education before VLL placement.

3.5 Data Collection

Quantitative instruments: Service quality and satisfaction were measured using a validated SERVQUAL instrument adapted for home nursing care settings (Babakus & Mangold, 1992). The adapted instrument comprised 22 items across five dimensions (tangibles, reliability, responsiveness, assurance and empathy), rated on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Internal consistency in this study was high (Cronbach's $\alpha = 0.92$). Student learning outcomes were assessed using structured self-report items measuring confidence in clinical assessment, communication and home-based care, developed and piloted in accordance with the VLL rotation objectives.

Qualitative data collection: Semi-structured, in-depth interviews were conducted with purposive samples of patients, family caregivers and nursing students to explore experiences of accessibility, responsiveness, empathy, trust and community co-creation within the VLL. Interviews were audio-recorded with consent, transcribed verbatim and anonymized. Interview guides were derived from the six theoretical domains and reviewed by two nursing education experts for content validity.

3.6 Data Analysis

Quantitative data were analyzed using SPSS (version XX) to generate descriptive statistics (means, standard deviations and percentages) for service quality and student learning outcomes. Qualitative data were analyzed using reflexive thematic analysis following Braun and Clarke's six-phase process: (1) familiarization; (2) coding; (3) generating initial themes; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report. Trustworthiness was enhanced through prolonged engagement in the field, peer debriefing among the research team, member checking with selected participants and maintenance of an audit trail. Mixed-methods integration was achieved through joint display analysis, in which quantitative SERVQUAL scores and qualitative themes were placed in a matrix to identify convergent and complementary patterns, and these integrated findings directly informed the final construction and validation of the PICVL-NM ecosystem model.

3.7 Ethical Considerations

Ethical approval was granted by the Shinawatra University Institutional Review Board (Protocol No. IRBS 23/17). All participants provided written informed consent prior to data collection. Participation was voluntary, and withdrawal did not affect care or academic standing. All data were anonymized and stored securely in accordance with institutional and international research ethics standards.

4. RESULTS

4.1 Participant Characteristics

A total of 166 participants completed the study: 10 patients, 24 family caregivers and 132 undergraduate nursing students. Patients were community-dwelling adults with chronic conditions (e.g., hypertension, diabetes, post-stroke sequelae) requiring ongoing home nursing care. Caregivers were primary family members co-residing with patients. Nursing students were enrolled in years 2–4 of the four-year Bachelor of Nursing Science programme and undertaking a structured community rotation within the VLL.

4.2 Quantitative Findings: Service Quality and Satisfaction

Overall satisfaction with home nursing care was high across all stakeholder groups, with mean scores ranging from 4.06 to 4.17 on a five-point Likert scale (Table 1).

Table 1. SERVQUAL Domain Mean Scores by Stakeholder Group

SERVQUAL Domain	Patients (n = 10)	Caregivers (n = 24)	Students (n = 132)	Interpretation
Tangibles	3.83	3.95	4.00	High
Reliability	4.10	4.12	4.08	High
Responsiveness	4.63	4.60	4.61	Very High
Assurance	4.15	4.18	4.17	High
Empathy	4.58	4.50	4.55	Very High
Overall Mean	4.06	4.12	4.17	High

Likert scale: 1.00–2.49 = Low; 2.50–3.49 = Moderate; 3.50–4.29 = High; 4.30–5.00 = Very High

Responsiveness and empathy achieved very high levels across all groups, consistent with the relational and person-centered conditions of home-based care. Tangibles scored comparatively lower across groups, reflecting inherent physical resource limitations of household settings; however, integration of tele monitoring and smart devices partially mitigated these constraints.

4.3 Student Learning Outcomes

Following completion of the VLL rotation, 87.1% of nursing students (n = 115/132) reported increased confidence in clinical assessment, patient communication and home-based care delivery. Students rated role clarity and practice suitability particularly highly (mean = 4.61), indicating that structured year-based role progression effectively calibrated learning challenges and facilitated progressive competency acquisition.

4.4 Qualitative Findings: Thematic Analysis

Reflexive thematic analysis identified three overarching themes that described participants' experiences of the VLL ecosystem (Table 2).

Table 2. Qualitative Themes, Descriptions, and Exemplar Quotations

Theme	Description	Exemplar Quotation
1. Accessibility and Responsiveness	Participants described improved access to nursing care, timely response to health needs, and reduced barriers to seeking help within the home environment.	<i>"The students came to our home quickly when I needed help. I did not have to travel or wait."</i> (Patient)
2. Empathy and Trust-Building	Home-based interaction fostered authentic relational engagement, emotional presence and sustained trust between students, patients and caregivers.	<i>"They took time to listen and understand our family situation. I felt safe with them."</i> (Caregiver)

3. Community Co-Creation	Students, community members and faculty described shared ownership of the learning and care process, characterized by mutual respect, co-design and sense of partnership.	<i>"We were not just patients—we were part of teaching the students how to care well."</i> (Patient)
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These themes confirm the relational, participatory and co-creative dimensions of the PICVL-NM, and converge with the quantitative findings of very high responsiveness and empathy scores.

4.5 The PICVL-NM Ecosystem Architecture

Integration of conceptual synthesis and empirical evidence produced the PICVL-NM, a four-domain ecosystem architecture for undergraduate community nursing education (Figure 1). Quantitative evidence validated the measurable output domain (high satisfaction, very high responsiveness and empathy, enhanced student confidence), while qualitative themes confirmed the operational process domain (relational depth, co-creation and contextual adaptability). Convergent findings further validated the theoretical foundations domain by demonstrating that Watson's caring constructs, SERVQUAL quality dimensions and SDG-oriented outcomes were all operationally realized within the VLL rotation.

Model Validity Criteria Met:

Validity Type	Evidence
Construct validity	Alignment between theoretical domains and empirically observed outcomes
Operational validity	Demonstrable implementation within a real-world community household setting
Ecological validity	Applicability within authentic community environments
Replicability	Structured, documented components enabling adaptation in other VLL and community nursing contexts

5. DISCUSSION

5.1 Summary of Key Findings

This study introduced and empirically grounded the PICVL-NM as an integrated nursing ecosystem architecture for undergraduate community education. High satisfaction across patients, caregivers and students, and substantial gains in student confidence, provide empirical support for the model's capacity to link educational design, service quality and community engagement within a single operational framework. The elevation of responsiveness and empathy to very high levels, and the emergence of trust, accessibility and co-creation as dominant experiential themes, indicate that the PICVL-NM successfully operationalizes its theoretical foundations in real-world community practice.

5.2 Responsiveness and Empathy as Structural Educational Outcomes

The very high scores for responsiveness and empathy are explicable through the structural logic of the PICVL-NM. By situating nursing practice within patients' homes, the model creates conditions that Watson (2021) describes as a "healing environment"—one in which unhurried, person-centered interaction is structurally protected. This contrasts with hospital environments where empathy is constrained by time pressure and workflow demands. These findings extend prior evidence by suggesting that empathy and responsiveness in nursing education are structurally produced by care environment design, not solely dependent on individual communication training. For educators, this implies that curriculum changes that reposition

students within authentic community settings—rather than adding isolated empathy training modules—may be more effective in developing relational competencies.

The relatively lower tangibles scores reflect inherent physical resource limitations of home environments. However, the integration of tele monitoring and smart devices within the VLL partially mitigated these constraints, suggesting that digital augmentation is not merely supplementary but structurally important for maintaining perceived care quality in decentralized, community-based education settings (Topol, 2019; Keesara et al., 2020).

5.3 Student Learning: Role Clarity, Self-Efficacy and Progressive Competency

The high score for role clarity and practice suitability (mean = 4.61) and the high proportion of students reporting increased confidence (87.1%) confirm the effectiveness of the structured pedagogical design embedded in the PICVL-NM. These findings align with Bandura's social cognitive theory, which identifies mastery experience as the most influential source of self-efficacy development. The VLL's year-based role progression provides appropriately calibrated learning challenges, enabling students to build competency through incremental, real-world experiences rather than simulated tasks alone.

Relatively lower scores in interpersonal trust-building highlight the complexity of relational dynamics in home-based care. Unlike hospital environments, home settings require students to navigate professional boundaries within family structures, manage diverse household dynamics, and sustain therapeutic relationships over time. This finding suggests that future VLL-based curricula should incorporate structured relational competency training, including supervised reflective practice, communication frameworks and facilitated debriefing sessions, as integral components of community rotation design.

5.4 Comparison with International Evidence

The PICVL-NM shares features with international living laboratory and community nursing initiatives but extends them in several ways. European living labs, for example, emphasize user-centered innovation yet are often not fully embedded in nursing curricula and rarely evaluate multi-stakeholder outcomes within a single framework. Similarly, community health schemes such as Singapore's Community Health Assist Scheme have improved access to care but remain primarily service-oriented and do not incorporate an explicit pedagogical architecture. In contrast, the PICVL-NM deliberately integrates educational design, service delivery and community co-creation within one empirically informed ecosystem, offering a structured template for curriculum development in community nursing education.

5.5 Theoretical and Practical Contributions (เพิ่มหัวข้อใหม่ แทนตำแหน่งเดิมของ 5.5)

Theoretical contributions

The PICVL-NM contributes to nursing education theory by synthesizing six established domains—caring science, service quality, joint venture learning, VLL infrastructure, holistic nursing and SDG-oriented sustainability—into a single ecosystem model that explicitly incorporates feedback loops between theory, practice and outcomes. This systems-based perspective responds to calls for frameworks that reflect the complex adaptive nature of contemporary health and education systems.

Practical implications

Practically, the model offers a transferable blueprint for designing community-based rotations that integrate digital health, structured role progression and triadic student–patient–caregiver relationships, while generating measurable indicators of service quality and student learning. This can guide institutions seeking to align undergraduate curricula with universal health coverage and the Sustainable Development Goals.

5.6 Implications for Curriculum Design and Policy

For nursing educators and curriculum planners, the PICVL-NM provides a structured blueprint for designing community-based clinical rotations that move beyond isolated placements toward ecosystem-oriented learning. Key implications include: (i) integrating VLL infrastructure as a recognized component of undergraduate clinical education; (ii) structuring year-based role progression to facilitate self-efficacy and competency growth; (iii) formally embedding triadic student–patient–caregiver interaction as a pedagogical mechanism; and (iv) aligning curriculum outcomes with the Sustainable Development Goals to position nursing graduates as contributors to sustainable health system transformation.

At a policy level, the model supports formal recognition of VLL rotations within national nursing education standards. It also offers a scalable approach to expanding community nursing capacity by coupling educational placements with service delivery, thereby contributing to community-based primary care development without proportionate increases in the nursing workforce—particularly relevant in resource-constrained and rapidly ageing health systems in Southeast Asia and globally (Frenk et al., 2010; WHO, 2017).

5.7 Strengths and Limitations

Key strengths of this study include: its convergent mixed-methods design enabling triangulation of quantitative and qualitative evidence; multi-stakeholder evaluation encompassing patients, caregivers and students; systematic integration of six theoretical domains; and real-world empirical grounding in an operational community nursing programme. The model also has potential for intellectual property registration and international adaptation, reflecting its structural clarity and documented components.

Limitations include: a single geographical context (one faculty, one community area in Thailand), limiting generalizability to other cultural and health system settings; the cross-sectional design of the empirical component, which precludes assessment of long-term outcomes; a small patient and caregiver sample; and the absence of cost-effectiveness data. Future research should address longitudinal patient health outcomes, cross-cultural validation across ASEAN and global contexts, multi-site comparative studies and cost-effectiveness analysis to strengthen the evidence base for wider implementation.

6. CONCLUSION

The Pitsachart Integrated Community–Virtual Living Nursing Model (PICVL-NM) reframes undergraduate community nursing education as a deliberately designed ecosystem rather than a series of isolated clinical placements. By integrating caring science, service quality intelligence, community co-creation, digital Virtual Living Laboratory infrastructure, holistic nursing and sustainability governance into a single architecture, the model makes explicit how theoretical commitments, learning processes and service outcomes can be aligned within real households and communities.

Convergent mixed-methods evidence from a Thai community-based VLL shows that this ecosystem design is not merely aspirational: patients and caregivers report consistently high satisfaction, responsiveness and empathy reach very high levels, and most students describe substantial gains in confidence and readiness for community practice. These results suggest that what students learn, how communities experience care and how health systems move towards equity are all shaped by the structure of the educational environment itself.

By demonstrating that responsiveness, empathy and trust can be systematically cultivated through ecosystem design, the PICVL-NM positions community nursing education as a strategic lever for service quality and community health, rather than a peripheral training activity. The model offers a concrete blueprint for curricula, university–community partnerships and policy initiatives seeking to operationalize the Sustainable Development Goals in everyday nursing practice. Future longitudinal, multi-site and cross-cultural studies are now warranted—not to prove that the ecosystem approach works, but to explore how far and how creatively it can be adapted to transform nursing education and community health systems worldwide.

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Conflict of Interest

The author declares no conflict of interest.

Ethical Approval

Ethical approval was granted by the Shinawatra University Institutional Review Board (Protocol No. IRBS 23/17). All participants provided written informed consent.

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