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From Task-Oriented to Person-Centered: Utilizing Mobile Technology to Foster Clinical Competence in Peripheral Intravenous Catheter Care Among Novice Nurses

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Title Page

Full Title: From Task-Oriented to Person-Centered: Utilizing Mobile Technology to Foster Clinical Competence in Peripheral Intravenous Catheter Care Among Novice Nurses

Running Title: M-learning for Person-Centered PIVC Care

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Declarations

Abbreviations

PIVC: Peripheral Intravenous Catheter; NENs: Newly Employed Nurses; RCT: Randomized Controlled Trial; RM-ANCOVA: Repeated Measures Analysis of Covariance; TAM: Technology Acceptance Model; PCC: Person-Centered Care; IRB: Institutional Review Board; SD: Standard Deviation.

Ethics approval and consent to participate

This study was approved by the Institutional Review Board of Hualien Tzu Chi Hospital (Approval No.: IRB109-231-B). All methods were performed in accordance with the relevant guidelines and regulations (Declaration of Helsinki). Written informed consent was obtained from all participants prior to their involvement in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to institutional privacy policies regarding nursing staff data but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YFC and HCC were responsible for the study conception and design. YFC and YT performed data collection and statistical analysis. HLH and JPC assisted with study implementation and pedagogical evaluation. PSC provided technical support for the mobile learning platform. YFC and HCC drafted the manuscript. All authors have read and approved the final version of the manuscript.

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Title: From Task-Oriented to Person-Centered: Utilizing Mobile Technology to Foster Clinical Competence in Peripheral Intravenous Catheter Care Among Novice Nurses

Abstract

Background

Traditional peripheral intravenous catheter (PIVC) care often follows a task-oriented approach, focusing primarily on successful insertion rather than continuous, person-centered monitoring. Newly employed nurses (NENs) frequently struggle with this transition due to high cognitive loads and the "theory–practice gap." This study evaluates the effectiveness of a mobile learning (m-learning) intervention, designed via the ADDIE framework, in fostering clinical judgment and empowering NENs to deliver person-centered PIVC care.

Methods

A pilot randomized controlled trial (RCT) was conducted at a tertiary medical center in Taiwan. Fifty-seven NENs were randomized into an experimental group (n=29, m-learning integrated with traditional training) and a control group (n=28, traditional training only). The m-learning content emphasized early complication recognition and patient comfort cues. Outcomes were measured using a validated PIVC Assessment Competence Scale at three time points: baseline (T0), week 2 (T1), and week 4 (T2). Repeated Measures ANCOVA (RM-ANCOVA) was employed, with educational level as a covariate.

Results

A significant Time * Group interaction effect was observed ($F = 3.76$, $p = .020^{*}$, partial $\eta^2 = 0.066$). While both groups showed initial improvement, the experimental group demonstrated superior longitudinal knowledge retention. At the 4-week follow-up (T2), the experimental group achieved significantly higher competence scores (75.2 ± 12.7) compared to the control group (66.4 ± 14.5, $p = .020^{*}$), yielding a medium-to-large effect size (Cohen's $d = 0.66$). Furthermore, the experimental group reported high overall satisfaction (4.52/5.0), specifically valuing the platform's "perceived usefulness" in supporting bedside decision-making.

Conclusions

Integrating m-learning into clinical orientation significantly enhances the clinical judgment of novice nurses, facilitating a shift from task-oriented routines to proactive, person-centered assessment. Mobile technology serves as an effective digital scaffold that sustains knowledge retention and promotes patient safety. Healthcare institutions should consider adopting technology-enabled pedagogical models to cultivate a culture of person-centered excellence in nursing. **Ethics Approval:** This study was approved by the Institutional Review Board of Hualien Tzu Chi Hospital (Approval No.: **IRB109-231-B**). Written informed consent was obtained from all participants.

I. Introduction

The global nursing paradigm is currently undergoing a fundamental shift from staff-centric, task-based routines toward person-centered care (PCC). This philosophy prioritizes the individual's unique needs, experiences, and safety through close, trusting relationships between healthcare professionals and recipients [1]. In clinical practice, PCC is recognized as the "gold standard," fostering improved communication and better health outcomes. However, the successful implementation of PCC relies heavily on the clinical judgment and competence of the nursing workforce [2].

Peripheral intravenous catheter (PIVC) insertion is a cornerstone of hospitalized care, with approximately 70%–80% of patients requiring infusion therapy. Despite being a routine task, PIVC-related complications—such as phlebitis, infiltration, and catheter-related infections—remain alarmingly high, ranging from 35% to 50% [4, 5]. From a person-centered perspective, these complications represent more than clinical failures; they cause significant patient distress, pain, and the trauma of repeated cannulations. Reducing these avoidable burdens requires nurses to possess high-level clinical reasoning and proactive assessment skills.

1.1 The Challenge for Novice Nurses: From Task to Person

Newly employed nurses (NENs) face a steep learning curve during their transition from academic training to clinical practice. This period is often characterized by "reality shock" and high cognitive load [2, 3]. Consequently, novice nurses frequently adopt a task-oriented mindset, focusing on the technical completion of procedures (e.g., "getting the line in") rather than the continuous, person-centered monitoring required to ensure patient comfort and safety.

Traditional clinical teaching, constrained by workforce shortages and heavy workloads, often fails to provide the real-time feedback necessary to bridge this "theory–practice gap" [6, 7]. When training is inconsistent, NENs may overlook subtle clinical cues of complications, leading to a breakdown in the quality of person-centered nursing.

1.2 Technology-Enabled Person-Centered Care

Advancements in digital technology, particularly mobile learning (m-learning), provide promising contributions to the evolution of PCC. M-learning enables "just-in-time" learning and repetitive practice at the point of care, empowering nurses to refine their clinical judgment asynchronously [9, 10]. According to the Technology Acceptance Model (TAM), the success of such tools depends on their perceived usefulness in solving real-world clinical pain points [12].

However, integrating technology into nursing is not without complexity. The "mobile learning paradox" suggests that while devices increase accessibility, they may also risk distracting staff from direct patient engagement [11]. To mitigate this, structured instructional frameworks like the ADDIE model are essential to ensure that digital tools serve as a "clinical scaffold" rather than a distraction [8].

1.3 Study Aim and Objectives

Despite the potential of m-learning, there is a lack of randomized controlled trials (RCTs) investigating its impact on the PIVC assessment competence of novice nurses, specifically regarding longitudinal knowledge retention. This study aims to evaluate whether a mobile technology intervention can facilitate the transition from task-oriented to person-centered PIVC care.

The specific objectives were:

1. To compare longitudinal learning outcomes: Evaluate differences in PIVC-related clinical judgment between m-learning and traditional teaching groups across three time points (Baseline, Week 2, and Week 4).
2. To assess knowledge retention: Determine the sustained impact of the digital intervention on competency levels over a one-month period.
3. To evaluate user acceptance: Assess the feasibility of m-learning as a tool for empowering NENs to deliver higher-quality, person-centered care.

II. Methods

2.1 Study Design and Setting

This study utilized a pilot randomized controlled trial (RCT) design to evaluate the longitudinal effectiveness of a mobile learning (m-learning) intervention. The study was conducted at a tertiary teaching medical center in Eastern Taiwan, following the ethical principles of the Declaration of Helsinki and the CONSORT guidelines. The study period took place during the 2022 fiscal year.

2.2 Participants and Recruitment

The study population consisted of newly employed nurses (NENs).

- Inclusion Criteria: NENs who had completed basic hospital orientation, were assigned to clinical units (ICU, surgical, or medical wards), and provided written informed consent.
- Sample Size: Using G-Power 3.1.9.7, the required sample size was determined based on a medium effect size ($f = 0.25$), power of 0.80, and $\alpha = 0.05$. Accounting for a potential 20% attrition rate, 84 participants were initially recruited (42 per group). After excluding dropouts due to clinical rotation or incomplete follow-up, 57 participants completed the full protocol (n=29 in the experimental group; n=28 in the control group).

2.3 Randomization and Blinding

Participants were randomly assigned to the experimental or control group in a 1:1 ratio.

- Randomization: An independent third party generated a random sequence using a computer-generated random number table.
- Allocation Concealment: Assignments were placed in sequentially numbered, opaque, sealed envelopes, which were opened only after baseline enrollment (T0).
- Blinding: Due to the nature of the educational intervention, blinding participants was not possible (open-label). However, analyst blinding was maintained; researchers performing data coding and statistical analysis were blinded to group assignments to minimize detection bias.

2.4 The "Person-Centered" Intervention (ADDIE Framework)

The intervention was developed using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) to transition NENs from a task-oriented to a person-centered mindset.

- Control Group (Traditional Teaching): Participants received standard printed materials and routine bedside guidance from clinical preceptors.
- Experimental Group (M-Learning Integration): In addition to traditional training, participants used a mobile platform designed to foster clinical judgment.
    - Content: High-definition instructional videos featured senior nursing experts demonstrating PIVC assessment. Unlike technical manuals, the content emphasized patient comfort cues, early detection of subtle complication signs (e.g., stage 1 phlebitis), and communication strategies to reduce patient anxiety.
    - Access: Participants were granted 24/7 unlimited access via personal devices for two weeks to facilitate "just-in-time" learning.
    - Validity: Materials were validated by five nursing experts, yielding a Content Validity Index (CVI) of 0.92.

2.5 Instruments and Outcome Measures

- Primary Outcome: PIVC Assessment Competence Scale. A validated tool measuring theoretical knowledge and clinical judgment (e.g., identifying infiltration vs. phlebitis). Data were collected at three time points: Baseline (T0), Week 2 (T1), and Week 4 (T2) to assess knowledge retention.
- Secondary Outcome: TAM-based Satisfaction Questionnaire. Administered at T1 to the experimental group to evaluate Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) on a 5-point Likert scale.
- Covariates: Baseline demographics, including educational level and usage frequency, were recorded to adjust for potential confounding.

2.6 Ethical Considerations

The study protocol was reviewed and approved by the Institutional Review Board of Hualien Tzu Chi Hospital (IRB109-231-B). As this was an educational intervention study conducted within a single institution and did not involve clinical drug trials or invasive patient procedures, formal registration in a public clinical trial registry was

not pursued prior to recruitment. However, the study strictly adhered to the CONSORT 2010 reporting guidelines to ensure transparency and methodological rigor.

2.7 Statistical Analysis

Data were analyzed using SPSS version 26.0.

1. Homogeneity: Independent t-tests and Chi-square tests compared baseline characteristics.
2. Interaction Effects: Repeated Measures Analysis of Covariance (RM-ANCOVA) examined the "Time * Group" interaction, with educational level as a covariate to ensure the findings were attributed to the intervention.
3. Intra-group Analysis: Paired t-tests evaluated the progression of scores within each group across time points. Significance was set at $p < .05$.

III. Results

3.1 Participant Flow and Demographic Characteristics

As depicted in the CONSORT flow diagram (Figure 1), 84 newly employed nurses (NENs) were initially randomized. Following an attrition rate of 32.1% due to clinical rotations and incomplete follow-up, 57 participants completed the study (Experimental: n=29; Control: n=28).

[Insert Figure 1 about here]

The cohort's mean age was 23.4 years, with a high predominance of females (93.0%). Clinical assignments were concentrated in the Intensive Care Unit (29.8%) and Surgical Wards (28.1%). Baseline analysis revealed no significant differences in gender, clinical unit, or prior PIVC experience ($p > .05$), ensuring initial homogeneity in professional background.

3.2 Baseline Imbalance and Covariate Control

Despite overall homogeneity, a statistically significant disparity was identified in the baseline educational background distribution between the two groups ($\chi^2 = 11.23$, $p < .001$***. The Control Group possessed a substantially higher proportion of participants holding bachelor's degrees (89.3%) compared to the Experimental Group (48.3%).

To meticulously isolate the unique effect of the mobile learning intervention from the confounding influence of pre-existing academic backgrounds, educational level was utilized as a covariate in the subsequent Repeated Measures Analysis of Covariance (RM-ANCOVA). in **Table 1**.

[Insert Table 1 about here]

3.3 Longitudinal Learning Outcomes and Interaction Effects

The cross-sectional comparisons (Independent Samples t-test) and longitudinal intra-group improvements (Paired Samples t-test) of PIVC assessment competence scores are consolidated in **Table 2**. At baseline (T0), no statistically significant difference was found between the Experimental and Control groups ($t = 1.234$, $p = .222$), confirming equivalence in pre-existing knowledge before the intervention.

[Insert Table 2 about here]

Longitudinal intra-group analysis revealed that the m-learning intervention yielded an immediate, powerful pedagogical effect; the Experimental Group exhibited a dramatic and highly significant initial score elevation from T0 to T1 ($\Delta M = 12.69 \pm 16.2$, $p < .001$^***). Crucially, during the post-intervention follow-up phase from T1 to the one-month evaluation (T2), the Experimental Group continued to demonstrate a statistically significant cumulative growth ($\Delta M = 7.24 \pm 15.1$, $t = 2.60$, $p = .020$*). Conversely, the Control Group failed to achieve statistically significant progress during either the initial phase (T0 vs. T1: $p = .220$) or the subsequent follow-up interval (T1 vs. T2: $p = .390$). Consequently, at the final one-month follow-up (T2), the Experimental Group achieved a significantly higher absolute competence score (75.2 ± 12.7) than their traditional counterparts (66.4 ± 14.5, $t = 2.427$, $p = .020$*), reinforcing the clinical efficacy of the digital scaffold.

To rigorously evaluate the intervention effect while controlling for the baseline educational imbalance, an RM-ANCOVA was performed (**Table 3**). The analysis revealed a statistically significant **Time * Group interaction effect** ($F(2, 106) = 3.763$, $p = .020$*, partial η p2 = .066), mathematically confirming that the learning trajectory of the m-learning experimental group was significantly more effective across the study period compared to the control group.

[Insert Table 3 about here]

As visually illustrated in the progression curve (**Figure 2**), both groups experienced an upward trend from baseline (T0) to the two-week post-test (T1). However, between T1 and T2, the Control Group exhibited a distinct **"Plateau Effect,"** stagnating at a

score of 66.4± 14.5. In sharp contrast, the Experimental Group demonstrated sustained, **"Cumulative Growth,"** advancing to a robust final competence level of 75.2 ±12.7.

Main effects for Time ($F = 1.703$, $p = .187$) and Group ($F = 2.926$, $p = .093$) did not reach significance independently, which underscores that the core value of the mobile platform lies in its capacity to generate a significant interaction over time—providing a robust digital scaffold that sustains long-term clinical judgment retention, a fundamental prerequisite for delivering consistent, person-centered nursing care.

[Insert Figure 2 about here]

3.4 Evaluation of User Acceptance and PCC Feasibility

Satisfaction scores from the experimental group (Table 4) reflect high feasibility for integrating mobile technology into person-centered nursing. The overall satisfaction mean was 4.52 ± 0.48 (on a 5-point Likert scale).

The highest-rated items—"User interface design is simple and clear" and "Provides critical clinical information" (both M = 4.54)—validate the system's alignment with the Technology Acceptance Model (TAM). Participants specifically valued the "just-in-time" availability of visual assessment cues, which they perceived as a vital support for ensuring patient safety and comfort in high-pressure environments.

[Insert Table 4 about here]

IV. Discussion

4.1 Enhancing Longitudinal Retention: The Cognitive Scaffold for PCC

The primary finding of this study is that the m-learning intervention facilitated a significantly more robust and sustained longitudinal improvement in PIVC assessment competence compared to traditional methods. The statistically significant Time * Group interaction effect ($F = 3.763$, $p = .020^{*}$) coupled with a medium-to-large partial effect size ($\eta p^2 = 0.066$) at the four-week follow-up strongly suggests that mobile-based microlearning acts as an effective **"cognitive scaffold"** for newly employed nurses (NENs).

Traditional clinical preceptorship often disproportionately focuses on the technical success of catheter insertion—a characteristically task-oriented approach. However, the experimental group's continuous and cumulative score improvement from two

weeks (T1) to one month (T2) indicates that "just-in-time" access to expert visual cues allows novice nurses to successfully internalize and retain the subtle clinical signs of complications, such as early-stage phlebitis or micro-infiltration. Within the framework of Person-Centered Care (PCC), this cognitive shift is pivotal; it systematically relocates the nurse's focus from "completing a technical procedure" to proactively "protecting the patient's physical comfort and vascular integrity" [9, 10]. By reducing technical uncertainty, the digital platform serves as a tool that translates evidence-based knowledge into compassionate clinical judgment at the bedside.

4.2 Overcoming the "Mobile Learning Paradox" in Clinical Settings

A significant contribution of this research is its empirical challenge to the "Mobile Learning Paradox." While previous literature expressed concerns that mobile device usage might appear unprofessional or cause clinical distractions [11], our findings—characterized by high satisfaction (4.52/5.0) and perceived usefulness (4.54/5.0)—suggest a different reality.

By institutionalizing the mobile platform as a formal clinical tool via the ADDIE model, the technology became an extension of professional competence rather than a personal distraction. When NENs perceive that a digital tool directly solves a clinical pain point (e.g., identifying a stage 2 infiltration), their engagement with the device is viewed by both the nurse and the patient as a commitment to high-quality, evidence-based care. This aligns with the Technology Acceptance Model (TAM), where "perceived usefulness" is the primary driver of digital integration in healthcare [12].

4.3 Smart Nursing as a Catalyst for Humanistic Care

From a broader perspective, this study echoes the core philosophy of "Humanistic Care" within the Tzu Chi Medical Foundation. The transition from task-oriented to person-centered care is often hindered by the high "learning anxiety" and cognitive load experienced by novice nurses during their first year.

By utilizing Smart Nursing technologies to provide real-time educational support, we effectively alleviate this anxiety. When a nurse feels confident in their assessment skills, they are less preoccupied with technical uncertainty and more available for meaningful, compassionate interaction with the patient. Thus, technology-enabled PCC does not replace the human touch; rather, it provides the professional security necessary for the "nursing heart" to focus on the individual's unique experience of illness.

V. Conclusions and Recommendations

5.1 Conclusions

This randomized controlled trial demonstrates that a blended learning strategy, seamlessly integrating m-learning with traditional clinical teaching, significantly enhances the PIVC assessment competence of newly employed nurses (NENs). The core contribution of this research lies in providing an empirical, evidence-based pedagogical model that successfully transitions novice nurses from a mechanical, task-completion mindset to a proactive, person-centered assessment approach. The long-term efficacy of this m-learning intervention is predicated on the structural integrity of the ADDIE design framework and its direct relevance to point-of-care patient safety.

5.2 Clinical and Policy Recommendations

Institutional Integration and "Cloud Nursing":

Healthcare organizations should transcend traditional, static orientation manuals by establishing **"Cloud Nursing"** repositories. These platforms should provide standardized, video-based micro-competencies accessible at the point of care. Such "just-in-time" digital resources empower newly employed nurses (NENs) to verify clinical cues in real-time, effectively bridging the theory–practice gap and ensuring that technical procedures are grounded in the latest evidence-based standards.

Professional Image and Digital Governance:

To resolve the "mobile learning paradox," hospitals must define clear institutional policies regarding the professional use of personal and mobile devices. By formalizing these tools as instruments for **"mobile-enhanced evidence-based practice,"** organizations can protect the professional image of nursing staff while fostering a culture where digital literacy is recognized as a core component of modern clinical excellence.

Synergizing Technical Skill with PCC Values:

Nursing orientation and residency programs should explicitly integrate technical skill acquisition with the core values of **Person-Centered Care (PCC)**. Training modules, such as PIVC assessment, should emphasize how accurate and proactive clinical judgment directly reduces patient suffering and prevents the trauma of repeated interventions. This alignment ensures that novice nurses do not merely "complete tasks" but actively advocate for the physical and emotional well-being of

the individual.

5.3 Limitations and Future Research

Despite the **statistically significant Time* Group interaction effect** (F(2, 106) = 3.763, p = .020*, partial η p2 = 0.066), certain limitations must be acknowledged. First, the study's **32.1% attrition rate**, though reflective of the high turnover challenges characteristic of modern novice nursing environments, may affect sample generalizability. Future multi-center longitudinal trials with larger cohorts are recommended to enhance external validity.

Second, the evaluation of competence was restricted to a validated written assessment scale. Future research should transition toward measuring direct clinical and patient-reported outcomes within a PCC framework, such as the actual incidence rates of phlebitis or infiltration, catheter indwelling times, and patient satisfaction with infusion care.

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References

1. World Health Organization (WHO). State of the world's nursing 2020: investing in education, jobs and leadership. Geneva: World Health Organization; 2020.
2. Benner P. From novice to expert: excellence and power in clinical nursing practice. Menlo Park: Addison-Wesley; 1984.
3. Missen K, McKenna L, Barnett T. Becoming a registered nurse: the transition experience of newly qualified nurses. A systematic review of qualitative literature. JBI Database System Rev Implement Rep. 2016;14(3):102-33. https://doi.org/10.11124/JBISRIR-2016-002339
4. Helm RE, Klausner JD, Klemperer JD, Widmer LM, Eggleston RB. Accepted but unacceptable: peripheral IV catheter failure. J Infus Nurs. 2015;38(3):189-203. https://doi.org/10.1097/NAN.0000000000000100
5. Alexandrou E, Ray-Barruel G, Carr PJ, Frost SA, Inwood S, Higgins N, et al. Use of peripheral intravenous cannulas in allied adults: a worldwide opportunistic prevalence study (SURE Study). J Hosp Med. 2018;13(5):311-6. https://doi.org/10.12788/jhm.2945
6. Ajani K, Moez S. Gap between knowledge and practice in nursing. Procedia Soc Behav Sci. 2011; 15:3927-31. https://doi.org/10.1016/j.sbspro.2011.04.396
7. O'Connor S, Hubner U, Shaw T, Blake R, Jauhiainen A. The future of digital health in nursing and midwifery education: a scoping review of the global literature. Nurse Educ Today. 2021; 98:104743. https://doi.org/10.1016/j.nedt.2021.104743
8. Branch RM. Instructional design: the ADDIE approach. New York: Springer; 2009.
9. Lee NJ, Chae SM, Kim H, Choi JH, Oh SJ. Mobile-based video learning outcomes in clinical nursing skills: a systematic review and meta-analysis. Nurse Educ Today. 2021; 98:104760. https://doi.org/10.1016/j.nedt.2021.104760
10. Koivisto JM, Haavisto E, Niemi H, Katajisto J, Multisilta J. Design principles for self-directed game-based learning environments: educating student nurses in clinical reasoning to detect a deteriorating patient. Nurse Educ Today. 2018;

60:154-61. https://doi.org/10.1016/j.nedt.2017.10.003

11. Banu J, George J, Gopi A. The mobile learning paradox: accessibility versus distraction in nursing education. Int J Nurs Sci. 2024;11(1):45-52. https://doi.org/10.1016/j.ijnss.2023.12.004

12. Venkatesh V, Davis FD. A theoretical extension of the technology acceptance model: four longitudinal field studies. Manage Sci. 2000;46(2):186-204. https://doi.org/10.1287/mnsc.46.2.186.11926

13. McCormack B, McCance T. Person-centred practice in nursing and health care: theory and practice. 2nd ed. Oxford: Wiley Blackwell; 2017.

14. Santana MJ, Manalili K, Jolley RJ, Zelinsky S, Quan H, Lu M. How to practice person-centred care: a conceptual framework. Health Expect. 2018;21(2):429-40. https://doi.org/10.1111/hex.12640

15. Kuipers K, Bright FA, Kayes NM, Papadimitriou C. The person-centered care model: a framework for clinical practice and research. Arch Phys Med Rahail. 2021;102(12):2445-53. https://doi.org/10.1016/j.apmr.2021.05.021

Tables and figures

Table 1. Baseline Characteristics of Participants (N = 57)

Variable	Total (N=57)	Control Group (n_1=28)	Experimental Group (n_2=29)	χ^2 / t	*p* - value
	n (%)	n (%)	n (%)		
Gender				0.25	.610
Male	4 (7.0)	1 (3.6)	3 (10.3)		
Female	53 (93.0)	27 (96.4)	26 (89.7)		
Clinical Unit				6.20	.180
Medical Ward	14 (24.6)	8 (28.6)	6 (20.7)		
Surgical Ward	16 (28.1)	4 (14.3)	12 (41.4)		
Intensive Care Unit (ICU)	17 (29.8)	11 (39.3)	6 (20.7)		
Emergency	3 (5.3)	2 (7.1)	1 (3.4)		
Others	7 (12.3)	3 (10.7)	4 (13.8)		
Education Level				11.23	.000**
Bachelor's Degree	39 (68.4)	25 (89.3)	14 (48.3)		
Associate Degree	18 (31.6)	3 (10.7)	15 (51.7)		
Frequency of Digital Platform Use				2.62	.270
1 time	27 (47.4)	14 (50.0)	13 (44.8)		
2–4 times	28 (49.1)	12 (42.9)	16 (55.2)		
>=5 times	2 (3.5)	2 (7.1)	0 (0.0)		
Independently Performed PIVC				1.34	.720
0 times	1 (1.8)	1 (3.6)	0 (0.0)		
1–4 times	11 (19.3)	6 (21.4)	5 (17.2)		
5–9 times	18 (31.6)	8 (28.6)	10 (34.5)		
>=10 times	27 (47.4)	13 (46.4)	14 (48.3)		
Number of Attempts for PIVC Success				1.16	.560
1 attempt	4 (7.0)	3 (10.7)	1 (3.4)		
2 attempts	40 (70.2)	19 (67.9)	21 (72.4)		
3 attempts	13 (22.8)	6 (21.4)	7 (24.1)		

Note: PIVC = Peripheral Intravenous Catheter. *p < .05 indicates statistical significance.

Table 2. Cross-Sectional and Longitudinal Comparisons of PIVC Assessment Scores (N=57)

Assessment Time Point	Experimental Group (n=29)	Control Group (n=28)	Between-Group Comparison †	
	M ±SD	M ±SD	t-value	p-value
Baseline (T0)	55.2 ± 12.9	59.3± 12.1	1.234	.222
Two-week Post-test (T1)	67.9± 12.6	63.6 ± 17.2	1.091	.280
One-month Post-test (T2)	75.2 ± 12.7	66.4 ± 14.5	2.427	.020*
Intra-Group Improvement †	Δ M ± SD	Δ M ± SD		
T0 vs. T1 (Initial Gain)	12.69 ± 16.2	4.29 ± 18.1	4.20 / 1.25	<.001*** / .220
T1 vs. T2 (Sustained Retention)	7.24 ± 15.1	2.86 ± 17.6	2.60 / 0.86	*.020 / .390**

Note. Δ M *indicates the mean changes between the two designated time points. p < .05, p < .001.*

†*Between-group comparisons were analyzed using Independent Samples t-test.*

† *Intra-group longitudinal improvements were analyzed using Paired Samples t-test; values represent (Experimental / Control) cohorts respectively.*

Table 3. Results of Repeated Measures Analysis of Covariance (RM-ANCOVA, N = 57)

Variable	Control Group (n=28)	Experimental Group (n=29)	Source of Variation	F Ratio	*df*	p	Partial ηp2
Assessment Score	M ±SD	M± SD	**Within-Subjects Effects**				
Baseline (T0)	59.3 ± 12.1	55.2± 12.9	Time (T)	1.703	2	.187	0.031
Two-week (T1)	63.6 ± 17.2	67.9 ± 12.6	**Time * Group**	**3.763**	**2**	**.020***	**0.066**
One-month (T2)	66.4 ±14.5	75.2± 12.7	Error (Time)	—	106	—	—
			Between-Subjects Effects				
			Educational Level	1.152	1	.288	0.021
			Group (G)	2.926	1	.093	0.052
			Error (Group)	—	53	—	—

*Note. *p < .05. Educational level was entered as a covariate to adjust for baseline imbalance between the two groups. Error degrees of freedom (df=106 for within-subjects and df=53 for between-subjects) are provided to ensure reporting transparency according to CONSORT guidelines.*

Table 4. User Satisfaction with the M-learning Platform (n=29)

Item	Satisfaction (M±SD)
1. The learning materials provided are very helpful for clinical practice.	4.46 ±0.51
2. The user interface design is simple and clear.	4.54 ±0.50
3. Links within the system make it easy to access required information.	4.53 ±0.51
4. The system quality and operation are stable.	4.49 ±0.51
5. The information provided is accurate and error-free.	4.53 ± 0.51
6. Provides critical information relevant to clinical practice.	4.54 ±0.51
7. The information provided meets my individual needs.	4.51 ± 0.51
8. Provides complete and trustworthy information.	4.54 ± 0.50
Overall Mean Satisfaction	4.52 ±0.48

Note: Measured on a 5-point Likert scale, with higher scores indicating higher satisfaction.

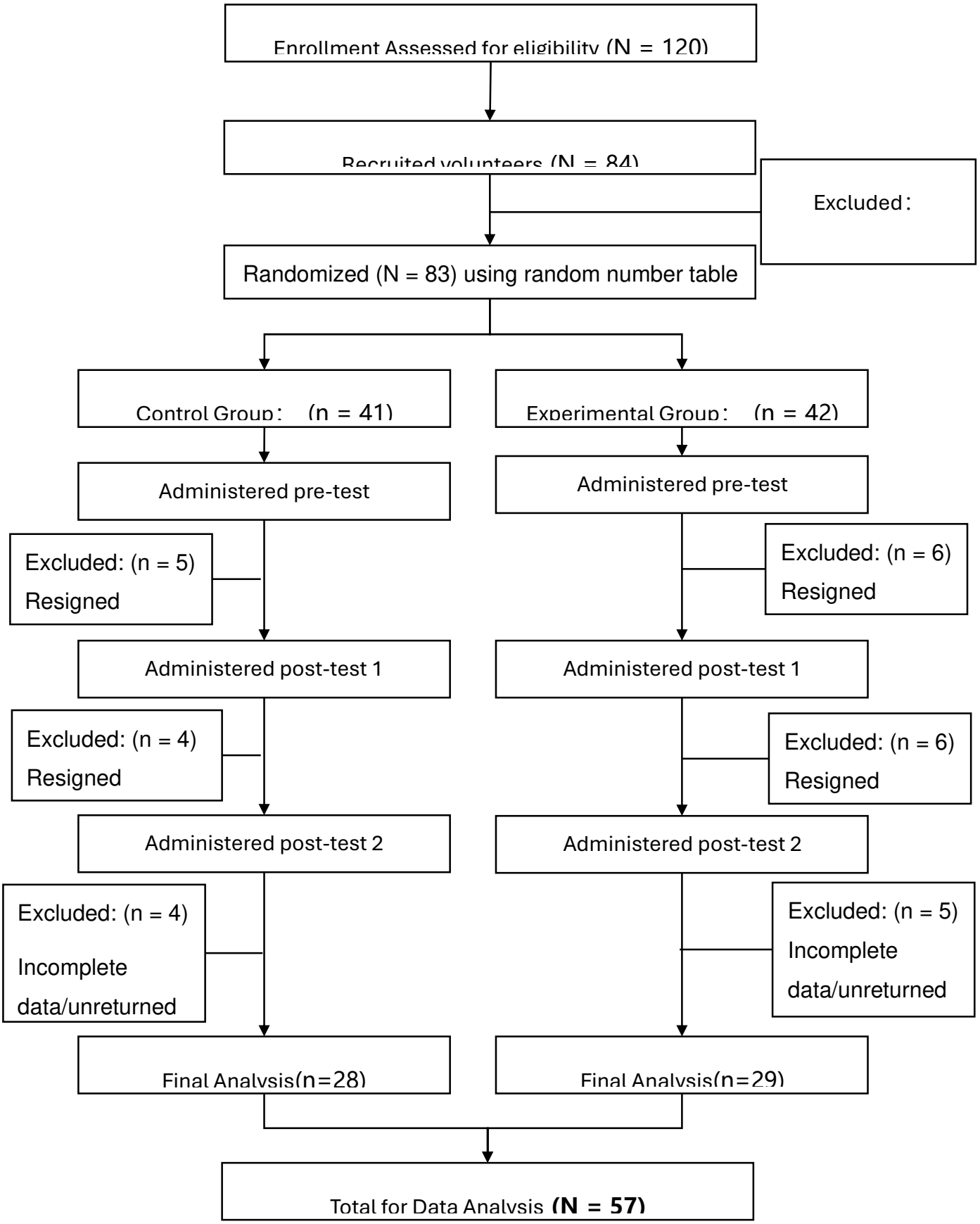

Enrollment Assessed for eligibility (N = 120)
Recruited volunteers (N = 84)
Excluded:
Randomized (N = 83) using random number table
Control Group: (n = 41)
Experimental Group: (n = 42)
Administered pre-test
Administered pre-test
Excluded: (n = 5)
Resigned
Excluded: (n = 6)
Resigned
Administered post-test 1
Administered post-test 1
Excluded: (n = 4)
Resigned
Excluded: (n = 6)
Resigned
Administered post-test 2
Administered post-test 2
Excluded: (n = 4)
Incomplete
data/unreturned
Excluded: (n = 5)
Incomplete
data/unreturned
Final Analysis(n=28)
Final Analysis(n=29)
Total for Data Analysis (N = 57)

Figure 1. CONSORT Flow Diagram of the Study

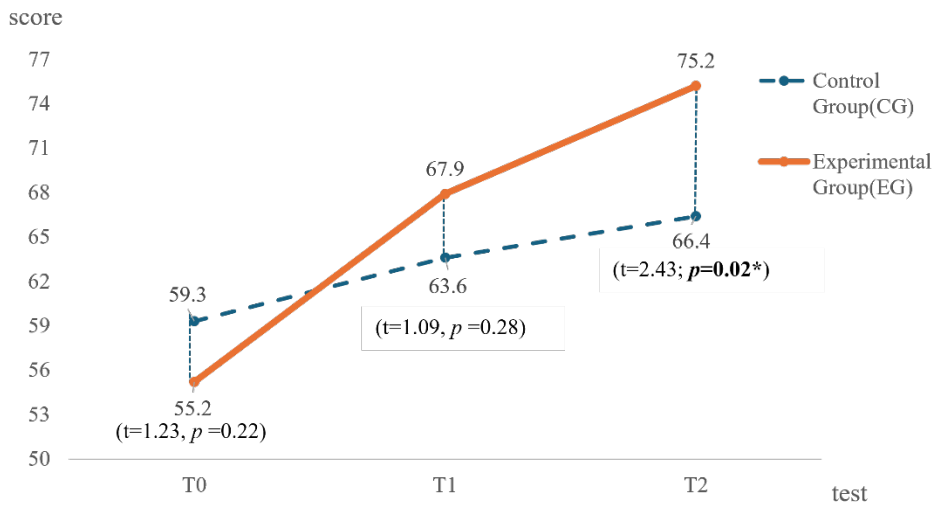


Figure 2. Progression of Clinical Judgment Scores in PIVC Assessment: Toward Person-Centered Competence. This line graph illustrates the divergent learning trajectories of the Experimental Group (EG, m-learning intervention) and the Control Group (CG, traditional teaching). At baseline (T0), no significant difference existed between groups ($p = 0.22^{*}$). While both groups showed early improvement at Week 2 (T1), only the Experimental Group demonstrated a sustained and significant increase at the Week 4 follow-up (T2), achieving a final score of 75.2 compared to the Control Group's 66.4 ($t = 2.43$, $p = 0.02^{*}$). The divergent paths underscore the superior knowledge retention and clinical judgment fostered by the digital scaffold.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFile1.docx