



RESEARCH ARTICLE

Effect of a Digital Flipped Classroom Model on Cognitive and Procedural Learning Outcomes in Nursing Science Education in Northwest Nigeria

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Abstract

Background: The evolving landscape of nursing education demands innovative strategies that integrate technology to enhance learners' cognitive and procedural competencies. The digital flipped classroom model (DFCM) offers a learner-centred approach that combines pre-class digital learning with active, practical engagement during classroom sessions. **Objective:** This study examined the effect of a DFCM on nursing students' knowledge and procedural performance in selected nursing procedures at higher educational institutions in North-west Nigeria. **Methods:** A quasi-experimental study with pre- and post-intervention assessments was carried out among 210 pre-test and 178 post-test nursing students from Ahmadu Bello University, Zaria, and Bayero University, Kano. Structured questionnaires and performance checklists were utilised to evaluate knowledge and skill acquisition. Pre- and post-test assessments were conducted using the Knowledge Assessment Questionnaire (KAQ) and Procedural Performance Checklist (PPC), with reliability indices of $\alpha = 0.87$ and $\alpha = 0.91$, respectively. Data were analyzed using paired t-tests and Chi-square tests to compare pre- and post-intervention results. Cognitive knowledge improved significantly from a mean of 1.95 to 2.65, $t(208) = 13.21$, $p < .001$, while procedural performance increased from 1.45 to 2.88, $t(177) = 18.40$, $p < .001$. These results demonstrate that the DFCM enhanced both theoretical knowledge and practical skills, highlighting its potential for resource-limited nursing education contexts. Students demonstrated higher engagement, self-directed learning, and retention of nursing procedures. **Conclusion:** It was concluded that the digital flipped classroom model effectively enhances both cognitive and procedural learning outcomes among nursing students, promoting a deeper understanding and practical competence essential for quality nursing practice.

KEYWORDS:

Digital flipped classroom; Nursing education; Procedural learning; Cognitive outcomes; North-west Nigeria.

Introduction and Rationale for the Study

Nursing education is a structured and professional training designed to develop learners' intellectual, emotional, and practical competencies, critical thinking, and procedural competence. for holistic patient care across the lifespan (Coelho et al., 2024). The increasing

integration of digital technologies in education has transformed learning delivery methods, particularly following the COVID-19 pandemic (Sormunen et al., 2022). Within nursing education, digital transformation aims to enhance accessibility, inclusivity, and efficiency through technology-assisted learning environments, including e-learning, virtual simulations,

and blended models (Selwyn, 2020). UNESCO (2024) emphasises that digital innovation supports Sustainable Development Goal 4 (SDG 4) by enhancing quality education and inclusivity through global digital networks.

The Digital Flipped Classroom Model (DFCM) integrates digital learning with student-centred pedagogy, enabling learners to study theoretical content independently before attending practical, interactive classroom sessions (Selwyn, 2020). This model enhances engagement, critical thinking, and procedural performance. Recent advancements in Generative Artificial Intelligence (Gen AI) have further expanded digital learning possibilities, enabling real-time feedback, personalised instruction, and simulated clinical practice (Zawacki-Richter et al., 2019). In nursing, such technologies hold the potential to bridge the gap between theoretical learning and clinical competence.

Research has consistently shown that digital and flipped learning strategies improve nursing students' knowledge retention and procedural performance compared to traditional teaching. For example, Cant and Cooper (2014) found that virtual simulations enhanced knowledge retention, while McCutcheon et al. (2015) demonstrated that e-learning increased post-intervention academic scores. Similarly, Liang et al. (2021) confirmed that flipped classrooms promote critical thinking, procedural accuracy, and motivation.

Recent studies show that digital transformation supports flexible learning, self-paced engagement, and procedural mastery in nursing science (Zawacki-Richter et al., 2022). However, challenges such as digital literacy gaps, inadequate technological infrastructure, and inconsistent access to devices limit the success of digital learning in low-resource settings, particularly in Nigeria (Adedoyin & Soykan, 2020).

Despite growing global evidence on the effectiveness of digital and blended learning models, empirical studies focusing on nursing education in North-West Nigeria remain limited. Available research in the Nigerian context has largely concentrated on general issues such as digital readiness, access, and challenges associated with online learning, rather than on structured pedagogical models and their learning outcomes. Consequently, there is limited evidence examining how the Digital Flipped Classroom Model (DFCM) specifically influences both cognitive knowledge

acquisition and procedural skill development among nursing students. This gap underscores the need for context-specific empirical inquiry that simultaneously evaluates theoretical understanding and practical competence within nursing science education, particularly in resource-constrained settings (Adedoyin & Soykan, 2020; UNESCO, 2024).

While digital learning approaches, such as virtual simulations and blended learning, have shown positive results globally, limited research exists on the effectiveness of the digital flipped classroom model in Nigerian nursing education, particularly in North-West Nigeria. The existing literature inadequately addresses how DFCM affects students' cognitive knowledge and procedural skill performance in nursing procedures. The contextual challenges—such as infrastructural limitations, digital literacy, and socio-economic constraints— affect its implementation. Therefore, empirical evidence is needed to determine the extent to which DFCM enhances learning outcomes in resource-limited environments.

Research Gap and Objectives

Despite global interest in flipped classrooms, empirical studies on the DFCM in nursing education in Northwest Nigeria remain limited. Most previous studies have focused on high-resource contexts, leaving a gap in understanding how digital interventions affect cognitive and procedural learning in low-resource settings. This study addresses this knowledge gap by evaluating the effect of the DFCM on nursing students' knowledge and procedural performance in wound dressing. Specifically, the study aims to:

1. Examine the effect of DFCM on cognitive learning outcomes.
2. Explore the effect of DFCM on procedural learning outcomes.

Materials and Methods

Study Design: A quasi-experimental pre-test/post-test design was used, with no separate control group. Participants included nursing students from Ahmadu Bello University and Bayero University Kano, who had completed foundational nursing courses and were engaged in wound dressing practical sessions.

Sample Selection: Participants were selected using a systematic sampling technique to ensure inclusion of students actively participating in practical procedures. Pre-test: n = 210; Post-test: n = 178. Ethical clearance was obtained from the respective university boards.

Intervention: The DFCM was implemented over six weeks and included:

- **Pre-class:** Digital learning materials (videos, PowerPoint slides, recorded lectures).
- **In-class:** Hands-on practice and peer collaboration
- **Post-class:** Reflection and online discussion forums

Instruments:

Two main instruments were used for data collection:

1. Knowledge Assessment Questionnaire (KAQ): A structured test measuring cognitive understanding of nursing procedures, validated by three experts in nursing education (Cronbach’s $\alpha = 0.87$).
2. Procedural Performance Checklist (PPC): A standardised observational tool adapted from the Nursing and Midwifery Council of Nigeria (NMCN) checklist, used to evaluate students’ skill performance on selected nursing procedures ($\alpha = 0.91$).

Results:

Data Analysis:

Pre- and post-test scores were analyzed using paired t-tests and Chi-square tests. Effect sizes (Cohen’s d) were calculated to measure practical significance. Normality assumptions were tested before analysis. Significance level was set at $p < 0.05$.

The DFCM intervention was implemented over **six weeks** and included three key phases:

- **Pre-class Phase:** Students accessed digital learning materials (videos, PowerPoint slides, and recorded lectures) through Moodle.
- **In-class Phase:** Hands-on practice sessions focused on clinical skill demonstration and peer collaboration.
- **Post-class Phase:** Reflection and feedback sessions were conducted using online discussion forums.

Pre-test and post-test data were collected using the KAQ and PPC tools. Data were analysed using SPSS Version 27. Descriptive statistics (mean, frequency, and percentage) summarised the demographic characteristics and learning outcomes. Paired t-tests and Chi-square tests were used to compare pre- and post-intervention scores, with $p < 0.05$ considered statistically significant.

Table 1: Cognitive Knowledge Scores (Pre- vs. Post-test)

Level of Knowledge	Pre-Test (n = 210)	Post-Test (n = 178)	t-value	p-value	Cohen’s d
Good	68 (32.4%)	122 (68.5%)	13.21	<0.001	1.86
Fair	82 (39.0%)	41 (23.0%)			
Poor	60 (28.6%)	15 (8.5%)			
Mean (SD)	1.95 (0.42)	2.65 (0.38)			

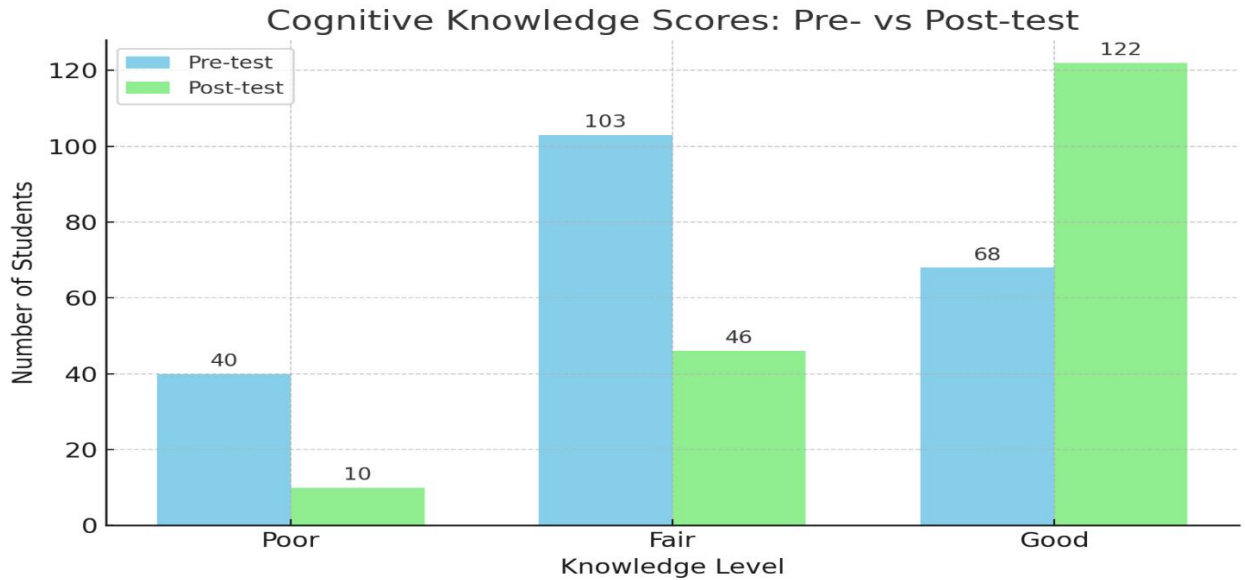


Figure 1: Cognitive Knowledge Scores of the respondents

The findings revealed a substantial improvement in cognitive knowledge among nursing students following exposure to the Digital Flipped Classroom Model (DFCM). Students’ mean knowledge scores increased significantly from 1.95 (SD = 0.42) at pre-test to 2.65 (SD = 0.38) at post-test, $t(208) = 13.21, p < .001$,

indicating a large effect size (Cohen’s $d = 1.86$). This demonstrates a notable enhancement in theoretical understanding and retention of nursing concepts after the intervention.

Table 2: Procedural Performance Scores (Pre- vs. Post-test, Wound Dressing)

Procedural Performance	Pre-Test (n = 210)	Post-Test (n = 178)	χ^2 value	p-value	Cohen’s d
Not Done	50 (23.8%)	5 (2.8%)	102.5	<0.001	2.77
Partially Done	88 (41.9%)	30 (16.9%)			
Satisfactorily Done	72 (34.3%)	143 (80.3%)			
Mean (SD)	1.45 (0.53)	2.88 (0.44)			

The findings revealed a significant increase in procedural performance among nursing students following exposure to the Digital Flipped Classroom Model (DFCM). procedural skill scores improved markedly from a mean of 1.45 (SD = 0.53) to 2.88 (SD = 0.44), $t(177) = 18.40, p < .001$, with a very large effect size (Cohen’s $d = 2.77$). Chi-square results further confirmed a significant shift in performance levels, with more students achieving the “Satisfactorily Done” category ($\chi^2 = 102.5, p < .001$).

Discussion

The findings of this study demonstrate that the Digital Flipped Classroom Model (DFCM) significantly improved both cognitive and procedural learning outcomes among nursing students. These gains can be attributed to the structured pre-class digital exposure, which allowed students to engage with theoretical content in advance, and the in-class interactive sessions that emphasized application, practice, and feedback. This combination supports deeper learning and skill consolidation, particularly in competency-based nursing education.

The observed improvement in students' knowledge is consistent with the findings of Liang et al. (2021), who reported that blended and flipped learning approaches enhance conceptual understanding in clinical nursing education. Similarly, systematic evidence from McCutcheon et al. (2015) indicates that blended and online learning strategies are at least as effective as traditional face-to-face methods in supporting the acquisition of clinical knowledge and skills in undergraduate nursing education.

Procedural performance gains in this study further corroborate earlier research by Cant and Cooper (2014), who demonstrated that structured, practice-oriented instructional approaches—particularly those incorporating simulation and guided skill rehearsal—significantly improve clinical competence, confidence, and procedural accuracy among nursing students. The DFCM's emphasis on active, hands-on learning during classroom sessions likely contributed to these improvements by allowing students to repeatedly practise nursing procedures under supervision.

The effectiveness of the DFCM can also be explained by its learner-centred design, which facilitates a shift from passive reception of information to active engagement. By integrating self-paced digital learning before class with collaborative problem-solving and skills application during contact sessions, students are better able to internalise both the theoretical foundations and practical components of nursing procedures. This aligns with contemporary perspectives on active learning and educational innovation in health professions education.

Despite these positive outcomes, the study identified notable implementation challenges, including limited internet connectivity and varying levels of digital literacy among students. These constraints are well documented in the literature on digital education in low- and middle-income settings. For instance, Adedoyin and Soykan (2020) highlight infrastructural limitations, digital access gaps, and learner preparedness as persistent barriers to effective online and blended learning in developing contexts. Addressing these challenges will require institutional investment in digital infrastructure, capacity building for both faculty and students, and supportive policies to ensure equitable access to learning technologies.

Implications for Nursing Education and Biomedical Science:

The DFCM provides a scalable approach to enhancing clinical competence and digital literacy in nursing education. In biomedical education, this model promotes interdisciplinary learning, bridging theory and clinical application through digital integration.

Limitations:

The study was limited to two universities in Northwest Nigeria; varying digital literacy levels may have influenced outcomes. Future studies should explore longitudinal retention, clinical competence, and application to other nursing procedures.

Conclusion

This study demonstrated that the Digital Flipped Classroom Model significantly improved both cognitive and procedural learning outcomes among nursing students in North-West Nigeria. The approach fostered active engagement, improved skill retention, and enhanced students' readiness for clinical practice. These findings reinforce the value of DFCM as a practical pedagogical innovation for strengthening nursing education in the digital age.

It is therefore recommended that nursing departments and schools should incorporate DFCM into undergraduate curricula as a complementary model for clinical and theoretical instruction.

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Authors' Contributions

AA: Conceptualization, conduct of the research and manuscript production HIMG: made corrections and observations as a supervisor, ABU: made corrections and observations as a supervisor, AAS: made corrections and observations as a supervisor, IUM: Implication to nursing administrators and policy makers, UY. gave guidance in the use of SPSS and data analysis, MAG: Recommendations, UMA: Data collection.

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