The Outcomes of Technology-Based Learning Management to Enhance Digital Health Competencies of Nursing Students at the College of Asian Scholars

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Abstract

This qualitative research aimed to study the outcomes of technology-based learning in enhancing digital health competencies among nursing students. The study followed the PDCA (Plan-Do-Check-Act) quality cycle framework. The key informants were purposefully selected, consisting of 95 second-year nursing students from Asia Graduate College, enrolled in the "Digital Nursing" course during the 2023 academic year. Data were collected through focus group discussions, and the reliability of the data was verified using triangulation methods, including cross-checking data sources, reviewing information, confirming data with key informants, and employing various data collection methods. The data were analyzed using content analysis and summarized into inductive themes.

The findings reveal that students expressed their perspectives on the need for technology-based learning, reflecting four key competencies identified by the nursing students: 1) Digital nursing knowledge must be contemporary, 2) Digital skills should be practical and technology-oriented, 3) Digital competency assessment and real-world learning, and 4) Positive attitudes toward the development of digital competencies, where learners must have a favorable outlook on technology.

Keywords: Learning Management; Technology Based; Digital Health Competencies

1. Introduction

Technology plays a crucial role in addressing VUCA conditions, which include volatility, uncertainty, complexity, and ambiguity. It enables businesses to adapt and enhance operational efficiency in rapidly changing environments. For instance, data analysis reduces volatility, while leveraging data to predict trends mitigates uncertainty. Additionally, technology simplifies business processes through systems like Enterprise Resource Planning (ERP) and Customer Relationship Management (CRM), and it addresses ambiguity via information technology and cloud systems.

In the educational sector, technology enhances access to information and improves learning management efficiency. Learners can access knowledge through the internet, and educational institutions can utilize online learning platforms to support unrestricted education. This includes creating diverse learning resources such as applications and tailored content. Furthermore, it fosters new teaching methods,

including video calls and game-based learning. Technology also aids in tracking progress and assessing learning outcomes through LMS (Learning Management Systems) and SIS (Student Information Systems), while developing students' technological skills to prepare them for society and the workforce. Moreover, it strengthens communication and collaboration among students, teachers, and educators (Lertwittayakul, T., 2023).

The role of health technology is crucial in the development and improvement of medical and health services, enhancing the efficiency of healthcare delivery. Its main functions include: 1) Diagnosis and Treatment: Technology facilitates faster and more accurate disease and health condition assessments. For example, artificial intelligence (AI) and machine learning are utilized for data analysis and disease trend predictions, while robotics assist in complex surgical procedures. 2) Telemedicine: It enhances communication and remote consultation, enabling healthcare professionals to connect with patients effectively. 3) Health Information Management: Technologies like Electronic Health Records (EHR) allow for quick and systematic storage and retrieval of patient data, reducing errors associated with paper documentation. Additionally, technology plays a role in preventive healthcare and monitoring, such as wearable devices that track vital signs and enable users to monitor their health closely. The use of health technology not only improves patient care and treatment efficiency but also enhances the quality of life for individuals and facilitates sustainable management of medical resources (World Health Organization, 2020; Topol, E., 2019; Sultan, N., 2015; McKinsey & Company, 2021).

The significant role of health technology has led to updates in the Bachelor of Nursing curriculum, which now includes a foundational course in digital nursing. This course aims for students to achieve expected learning outcomes in three areas: knowledge, skills, and attitudes toward digital literacy. (Bachelor of Nursing Curriculum, 2022). Based on the specified learning outcomes, the researcher has studied the digital literacy competencies of nursing students to define competencies within the course framework. According to the American Nurses Association (2020), digital competency encompasses the skills that nurses must possess in an era where information technology plays a vital role in healthcare. This competency refers to nursing students' ability to effectively utilize digital technology to enhance their skills and knowledge in health care. Furthermore, De Gagne, J. C., & Walters, K. (2010) identified several essential aspects of digital competency for nursing students: 1) Knowledge of Digital Technology: Students must have a foundational understanding of using software and hardware relevant to nursing, such as patient data management and health information systems. 2) Data Analysis and Health Information Management: Students should be able to access, collect, and analyze health data using digital systems, such as Electronic Medical Records (EMR), to aid in patient care decisions. 3) Use of Technology in Medical Communication: Students must possess skills to communicate effectively using technology, including video conferencing and telehealth consultations. 4) Digital Security: Knowledge of how to maintain the security of patient data and adherence to privacy practices is essential. 5) Positive Attitude Toward Technology: Students should have a

favorable outlook on using technology in healthcare and be adaptable to learning new technologies. 6) Use of Health Applications: Students must be proficient in using health-related applications, such as those for monitoring patient care and assessing patient symptoms. Given these competencies, the researcher emphasizes the importance of developing digital literacy among nursing students within the digital nursing course. A study by Choi, J. & De Gagne, J.C. (2016) concluded that these digital competencies are critically important in today's world, where technology plays a significant role in the healthcare system. Preparing nursing students to maximize the benefits of technology in patient care is essential.

From the literature reviewed on the digital competencies of professional nurses, several studies have been identified. Tangkrathok, P., Cheewakesuk, A., & Angsuchot, S. (2019) studied the components of digital competencies among Thai professional nurses, identifying a total of three components and 22 competencies: 1) Knowledge component with 7 competencies, 2) Skills component with 8 competencies, and 3) Characteristics component with 7 competencies. Rajphakdee, P. (2023) examined the digital competencies of newly graduated nurses and found that their overall digital competency was at a moderate level. The highest average was in digital usage, followed by digital awareness, adaptability to digital changes in nursing, and problem-solving in nursing using digital tools. Additionally, the satisfaction level of employers regarding the digital competencies of new nursing graduates was also found to be moderate. Weeraporn, N. et.al (2021) developed the digital competencies of nursing students, focusing on the analysis of digital technology skills in patient care situations. They recommended improvements to the nursing curriculum to enhance these competencies. The study highlighted the necessity for the Bachelor of Nursing curriculum to produce graduates equipped with knowledge, skills, characteristics, and positive attitudes toward using digital tools and solving nursing problems in response to the needs of employers in an era of transformation and a digital society.

Therefore, to prepare nursing graduates who will become professional nurses in a digital society, the researcher has incorporated digital literacy competencies—namely knowledge, skills, and attitudes towards digital technologies—as the intended learning outcomes in the "Nursing Digital" course. This study utilizes the PDCA (Plan-Do-Check-Act) quality improvement cycle and reflects the perspectives of nursing students through qualitative data analysis.

2. Objectives

To study the outcomes of technology-based learning management to enhance digital health competencies of nursing students at the College of Asian Scholars.

3. Literature Reviews and Research Frameworks

3.1 Theoretical Framework of Digital Competencies for Nursing Students: The digital competencies of nursing students encompass knowledge, skills, and positive attitudes or dispositions towards utilizing

technology to address nursing challenges. These competencies are designed to meet the demands of stakeholders in an era of transformation and a digital society, as outlined by Veeraporn, N. et al. (2021).

3.2 Theoretical Framework on Technology-Based Learning: Technology-based learning aims to cultivate a growth mindset in learners while engaging in educational activities. This approach encourages students to maximize their learning potential and foster creativity. When students adopt a growth mindset, they tend to exhibit behaviors that favor learning new things and continuously developing themselves (Lertwittayakul, T. 2023).

4. Methodology

4.1 This study utilized a qualitative research approach, employing action research methodology with the PDCA (Plan-Do-Check-Act) quality cycle. (Deming, W E. ,1986). The research was conducted over three cycles to examine the outcomes of technology-based learning management to enhance digital health competencies among nursing students. 10 Nurse students were discuses in focus group to reflect the students' perspectives on digital competencies in terms of knowledge, skills, and attitudes within the Nursing Digital course, as shown in Figure 1.

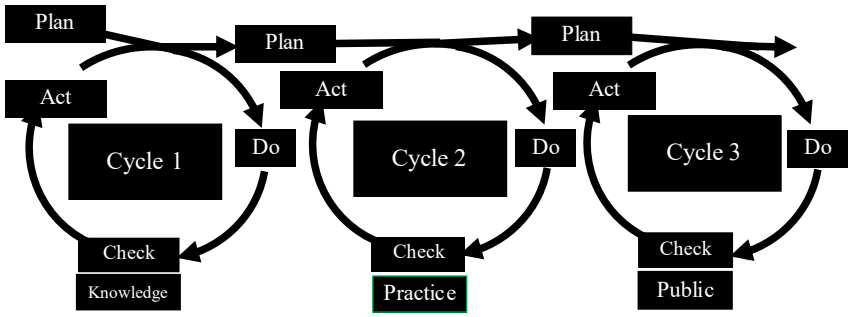

Figure 1 Three cycles of the PDCA quality cycle

4.2 The key informants were selected through purposive sampling, consisting of 95 second-year nursing students from the College of Asian Scholars who were enrolled in the Digital Nursing course during the 2023 academic year.

4.3 Research Ethics: The researcher ensured the protection of the sample group by providing detailed explanations to the key informants. This included information on the research objectives, participant qualifications, duration, data collection procedures, benefits to the participants, and the overall benefits of the study. The entire research process was explained thoroughly, and it was clarified that participation in the study would not affect the students' grades in the course.

4.4 Research Instruments: The research utilized a semi-structured interview guide developed by the researcher based on relevant concepts, theories, and studies on technology-based learning for nursing

students. The focus areas of the guide included: 1) Digital knowledge management, 2) Experience-based learning with technology, 3) Digital literacy competence assessment and real-world learning evaluation, and 4) Attitudes toward the development of digital competence. The interview guide was validated for content accuracy by three experts, with an index of item-objective congruence (IOC) of 1.00. Data collection also included observation, note-taking during the interviews, and audio recording.

4.5 Data Collection

1) The researcher explained the objectives, methods of data collection, and expected benefits, while also obtaining written consent for participation in the research. The participants were informed of their right to decline or withdraw from the study without providing reasons, and that such actions would not affect them. The researcher also provided opportunities for participants to ask questions and requested their cooperation in the data collection process.

2) The researcher conducted interviews based on a set of pre-established questions regarding the use of technology as a basis for learning management in the course. This covered aspects such as the organization of modern learning experiences, methods for managing practical clinical instruction that incorporates technology, and the assessment of learning outcomes based on real-life situations and technology. Each interview lasted approximately one hour, during which the researcher sought permission to record the conversation and took notes on the responses. Participants were given the freedom to provide information, and the researcher ensured the accuracy of the data by reviewing the information obtained from the interviews to ensure mutual understanding with the informants.

4.6 Data Analysis Method

The researcher analyzed the data obtained from the group discussions using content analysis and summarized the information inductively. The results of the interview analyses were presented back to the informants for verification to ensure the accuracy of the data. The credibility of the research findings was established through the following steps:

1) Credibility of Data: The researcher ensured the reliability of the data by selecting informants using purposive sampling based on specific characteristics.

2) Verification During Interviews: The researcher cross-checked the information during the interviews by reviewing the data obtained to ensure mutual understanding with the informants.

3)Transcription and Validation: The researcher transcribed the interviews verbatim and returned the transcripts to the informants for confirmation of accuracy before finalizing the conclusions. This was to ensure understanding and alignment with the informants' perspectives and feelings, thus confirming the validity of the data.

4) Cross-Verification with Other Data Sources: During the data collection from group discussions, the researcher also conducted observations to establish connections and consistency with information obtained from various documents. This was to assess whether the information collected was accurate,

appropriate, and relevant to the research questions, thereby enhancing the understanding of the data derived from the group discussions.

5. Results

5.1 Characteristics of Key Informants And Area of Focus

This study involved 95 nursing students as key informants who provided insights on using technology as a basis to enhance digital health competencies. Most participants were 86 female (90.53%), and 9 male (9.47%).

The areas of focus included:

1) Digital Knowledge Management: Students highlighted the importance of understanding digital tools and resources essential for effective nursing practice. They discussed how technology can streamline information retrieval and enhance knowledge sharing.

2) Learning Experience Management in Technology: The participants emphasized the need for practical learning experiences that incorporate technology. They suggested that simulation-based learning and hands-on practice with digital tools are crucial for developing skills in real-world scenarios.

3) Assessment of Digital Literacy Competencies: The nursing students pointed out the significance of evaluating digital competencies through practical assessments. They advocated for the use of e-portfolios and digital assessments to gauge their understanding and application of digital tools in patient care.

4) Attitudes Towards Digital Competency Development: The key informants expressed positive attitudes toward the integration of technology in nursing education. They recognized that developing digital competencies is vital for their future roles in healthcare and for enhancing patient outcomes.

Detailed Insights: The participants' responses provided valuable information on how technology can support their learning and development in digital health competencies. They identified various strategies and practices that can be employed within the nursing curriculum to ensure they are well-prepared for a technology-driven healthcare environment.

5.2 Outcomes of Technology-Based Learning Management in the Digital Nursing Course for Nursing Students

The researcher implemented the principles of Action Research following Deming's quality cycle across three iterations. Each iteration consisted of four stages: 1) Planning (Plan), 2) Implementation (Do), 3) Evaluation (Check), and 4) Improvement (Act). Detailed descriptions of the operations within each iteration are presented in Table 1.

Table 1: Describe Deming Cycles Steps

Deming cycle	Cycle1: Knowledge 15 hrs Learning Management Plan	Cycle2: Practice 30 hrs. Practice Training Plan	Cycle3: Public 8 hrs. Disseminating Results Plan
P Plan	**P11: Orientation** **-Teaching Team:** Introduce the teaching team to the students, highlighting their expertise and roles in facilitating the course. **-Students:** Provide an overview of the course objectives, expectations, and the importance of digital competencies in nursing practice. **P12: Learning Outcomes** -Clearly define the expected learning outcomes, focusing on the development of digital health competencies, including: -Understanding digital tools and resources relevant to nursing. -Demonstrating practical skills in utilizing technology for patient care. -Exhibiting positive attitudes toward continuous learning and adaptation in a digital environment. **P13: Teaching Methods** -Utilize a variety of teaching methods to engage students, such as: -Lectures: Deliver theoretical knowledge related to digital health and technology in nursing. -Workshops: Conduct hands-on sessions where students can practice using digital tools. -Group Discussions: Encourage collaborative learning and sharing of experiences among peers. -Simulation-Based Learning: Implement simulations that mimic real-world clinical scenarios to enhance practical application. **P14: Digital Experience Management** -Create opportunities for students to engage with technology through:	**P21: Orientation** -Coaching Team and Learners relationship **P22: Learning outcomes:** -Development of Nursing Applications **P23: Selection of Application Development Programs:** Line OA official, Mobile application, web application **P24: Application Development Process**: -Ideation or discovery phase -Planning phase -Design phase -Development phase -Quality assurance and testing.	**P31: Prepare for Classroom Presentations:** -Coaching from coaches **P32: Prepare for Presentations at National and International Levels** -Collaborative Learning **P33: Real-World Learning:** -Poster presentation -Oral presentation

Deming cycle	Cycle1: Knowledge 15 hrs Learning Management Plan	Cycle2: Practice 30 hrs. Practice Training Plan	Cycle3: Public 8 hrs. Disseminating Results Plan
	Online Platforms: Use learning management systems (LMS) for course materials, discussions, and assignments. -Virtual Simulations: Integrate digital simulations that allow students to practice clinical skills in a safe environment. -Collaborative Projects: Facilitate group projects that require the use of digital tools for research and presentation. **P15: Assessment Methods** **Develop a comprehensive assessment strategy to evaluate student learning**, including: -Formative Assessments: Use quizzes, reflective journals, and peer evaluations to monitor progress throughout the course. -Summative Assessments: Conduct practical exams and project presentations that demonstrate the application of digital competencies. -Feedback Mechanisms: Provide constructive feedback on assessments to guide students in their learning journey.		
D DO	**D11: Assessment of Learners' Diagnostic Before Learning** -Test learners' learning style **D12: Fundamental Knowledge of Digital** -Basic knowledge in digital **D13: Technologies:** Evaluate students' existing understanding of digital concepts and technologies relevant to nursing. **D14: Digital Nursing:** Assess students' awareness and comprehension of how digital tools and technologies are integrated into nursing practice. **D15: Review of Literature and Related Research in Nursing and Digital Health:** Conduct a review of relevant literature and	**D21: Small Group** **D22: Analyze Issues in:** **-**Nursing Service, Nursing Administration, Nursing Education, and Legal and Ethical Professional Standards **D23: Select Application Development Program** **D24: Implement:** Development application under the Supervision of Applicators **D25: Report** on the Progress of Application Development	**D31: Content Development and Preparation of the Application for**: -Dissemination of Results **D32: Development of Leadership Skills for:** -Presentation **D33: Problem-Solving Skills** **-**during public

Deming cycle	Cycle1: Knowledge 15 hrs Learning Management Plan	Cycle2: Practice 30 hrs. Practice Training Plan	Cycle3: Public 8 hrs. Disseminating Results Plan
	research studies that explore the intersection of nursing practices and digital innovations. **D16: Digital Tools:** Evaluate familiarity and proficiency with various digital tools, including applications, artificial intelligence (AI), and the metaverse, that can enhance nursing practice and education.	**D26: Summarize and Synthesize:** -Nursing Content in application's Development	
C Check	**C11: Teacher's observation** **C12: Learners' Reflection** **C13: Assessment of Digital Knowledge Competencies Through Testing: Evaluate students' digital knowledge competencies using a structured test.**	**C21: Teacher's observation** **C22: Learners' Reflection** **C23: Evaluation of Progress in Application Development** **C24: Reflection on Problems and Obstacles** **C25: Assessment of Digital Skill Competencies from Work Outputs**	**C31: Teacher's observation** **C32: Learners' Reflection** **C33: Assessment of Attitudes and Digital Attributes**
A Act	**A11: Learners' reflection to continuous improvement next cycle**	**A21: Learners' reflection for continuous improvement next cycle**	**A31: Learners' reflection for summarize learning model**

5.3 Learning Outcomes Across the Three Cycles: Students successfully developed 10 Nursing Applications, including the following:

Table 2: Nursing Applications

Nursing Applications	Application Details
1. Save Sex Love	- Education on Safe Sexual Practices to Prevent Sexually Transmitted Diseases
2. DSPM	- Child Growth and Development Recording
3. Take care your health food	- Age-Appropriate Nutritional Care
4. Save patient	- Managing Patient Complaints During Healthcare Services
5. Good mood	- Daily Emotional Monitoring
6. Mom all about	- Knowledge for First-Time Mothers
7. Therapeutic Sound	- Curated Sound Collection for Elderly Relaxation

Nursing Applications	Application Details
8. Mediplansion	- Medication Management Planning
9. "Modern Health"	- Monitoring Weight, Height, and BMI Beyond Standard Limits
10. "Quality Pregnancy"	- Guidelines for Pregnancy Care

5.4 Reflection on the Outcomes of Technology-Based Learning Each cycle of this study provided the following findings:

1) Modernization of Digital Nursing Knowledge: Students reflected on the integration of technology into their learning process, emphasizing that digital knowledge in nursing must remain current. They noted that this approach aligns with the competencies needed in the digital era and is crucial for applying new nursing knowledge in health planning and management. As students expressed:

"At first, I didn't understand why we needed to learn digital skills, but after the course, I realized how important it is for nurses to master digital tools." (SN1)

"Learning about new digital tools from the Applicators was exciting and extremely beneficial." (SN2)

"This is a very modern course." (SN3)

"The knowledge is so relevant to today's world and showed me how to apply it in nursing practice." (SN4)

2) Digital Skills Must Be Practiced and Technology-Based: Students provided insightful reflections on developing digital skills, emphasizing the importance of hands-on experience. They highlighted that true competency emerges through practical application, and technology facilitates systematic access to information. They also appreciated the opportunity to develop nursing applications using simple programs on their own. As students shared:

"At first, I was quite anxious because I had never built an application before, but once the instructor guided us through it, I felt capable and challenged myself." (SN3)

"I liked that we had to research, propose ideas in small groups, and it made me excited to create and see how our app would look." (SN6)

"Even though I faced challenges during the process, the instructor encouraged and motivated me to persevere until I succeeded." (SN7)

"Presenting our progress regularly while developing the app eased my anxiety, and I could use the instructor's feedback to improve further." (SN8)

"It was amazing! I never thought I could actually build an app." (SN9)

3) Assessment of Digital Competencies and Real-World Learning: Students provided valuable reflections on the evaluation of digital competencies and real-world learning, noting that the assessment covered all three key competencies: knowledge, skills, and attitudes. They appreciated the use

of diverse assessment tools, including evaluations based on the real-world application of the nursing apps they developed. As students reflected:

"The instructor continuously assessed us throughout the learning process, from pre-tests, exams, and presentations, to tracking project progress." (SN9)

"The evaluation was well-balanced: 40% for knowledge, 40% for skills, and 20% for attitudes." (SN10)

4) Attitudes Towards the Development of Digital Competencies: Students expressed positive attitudes toward developing digital competencies, recognizing their importance and confidently applying them in their future professional careers. As students reflected:

"Developing digital skills makes us think about how they will benefit us in caring for patients in the future." (SN2)

"I feel like a modern nurse." (SN5)

"I really enjoy this type of learning because I can see how we can create apps to educate patients." (SN9)

6. Discussion

The development of digital competencies among nursing students is essential and aligns with the requirements of the Bachelor of Nursing Science curriculum, which aims to prepare nurses for professional practice in a digital society. Through the implementation of technology-based learning in the course "Digital Nursing," nursing students have developed digital competencies across three domains: knowledge, skills, and positive attitudes towards technology. This aligns with findings from Thangkrachot, P., Cheevasemsuk, A., & Supamas Angsuchot (2019), as well as Ratchapakdee, P. (2023) and Veeraphorn, N. et al. (2021), who summarized the digital competencies of Thai nurses as consisting of three key components: knowledge, skills, and attributes. The development of digital competencies in nursing students is crucial for producing graduates who possess the necessary knowledge, skills, and positive attitudes required for solving nursing-related problems, in response to the demands of employers in an era of rapid change and digital transformation. Moreover, this aligns with the findings of Deelertpaiboon, S. et al. (2023) in their study on "Digital Literacy Development of Professional Nurses," which emphasizes that nurses must develop digital competencies in the following areas: understanding digital literacy, utilizing digital skills, solving problems using digital tools, and adapting to digital transformation. And also Arayasinlapathon, N., Somkumlung, P., Punaglom, N. (2024) described the digital competencies for nursing students consisted of 8elements:1) Digital literacy2) Digital skills3) Attributes4) Critical thinking and Problem solving 5) Adaptive and Learning 6) Ethics, Law, and Security 7) Communication & Collaboration and 8) Creative and Innovations.

7. Conclusions

Digital learning management suitable for nursing students should promote and develop digital competencies across all subjects, both theoretical and practical. This approach is essential to align with the changing society and to ensure that students can effectively utilize technology to its fullest potential.

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