Title:

Development and Implementation of a System Enabling Real-Time Simulated Nursing Practice and Educational Content Creation from Nurse, Patient, and 360-Degree Perspectives

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Abstract:

This project aims to support the digital transformation (DX) of nursing education by improving the working conditions of faculty and preparing students to function effectively in healthcare environments equipped with ICT technologies. Through the adoption of digital systems, we strive to enhance educational efficiency and evaluate their impact, thereby contributing to the overall promotion of DX in nursing practice.

As a model school, we implemented and verified the effectiveness of specific ICT-based educational methods. One such effort was the development and deployment of a system using smart glasses that enables real-time simulation of nursing techniques and practice from nurse, patient, and 360-degree perspectives, facilitating the creation of educational materials.

Using smart glasses and low-latency multi-site communication tools, we conducted three joint classes between two nursing schools and one class at a single institution. The objectives were: (1) reducing overtime and workload caused by faculty shortages, (2) addressing the decline in student competency—particularly in hands-on experience and communication skills, and (3) promoting system scalability and adaptability.

As a result, video material creation time was reduced by 77.2%, and faculty workload was eased by 63.3% (±17.5). Over 95% of students reported enhanced clarity in learning outcomes through immersive simulations viewed from multiple perspectives. Although comprehension declined slightly after one month, motivation and perceived learning value remained stable.

Conclusion

Reduction of Overtime and Workload for Nursing Faculty through Efficient Educational Material Creation

Before system implementation, the time required for creating video teaching materials (planning, filming, and editing) ranged from 63 to 180 minutes, with an average of 129 minutes (±71.3). After the system was introduced, this time was reduced by 77.2%. Since educational content could now be created from not only the nurse's perspective but also from the patient's and a 360-degree viewpoint during class, the efficiency of material

production improved beyond just time reduction. The perceived burden of educational material creation was also reduced by 63.3% (±17.5). Interviews with the four instructors who conducted classes revealed both challenges (e.g., camera positioning with smart glasses and class structuring) and advantages (e.g., easier video content development). It is expected that further reductions in faculty workload can be achieved through cross-institutional collaboration and increased familiarity with the system.

Providing Simulated Experiences for Students with Limited Hands-on Practice

In terms of enhancing clarity—understanding content, identifying ambiguities and key points, and improving interpersonal skills—over 95% of students (n=233) responded “strongly agree” or “agree” immediately after class. The system also positively influenced the affective domain, with 86% reporting a strong sense of fulfillment and satisfaction, 73% expressing a desire to use the system again, and 86% wanting to engage in repeated learning using it. A follow-up one month later showed a 0.3-point decrease in content clarity ($P<0.001$), but perceived value and motivation remained stable. The potential for further learning effectiveness was suggested through the use of Learning Management Systems (LMS) for video distribution. Additionally, the chat feature made students’ learning processes, questions, and reactions visible, allowing unclear points to be revisited during class through the nurse’s perspective.

However, audio quality posed issues. In single-institution classes, howling did not occur, but in joint classes with two institutions, some howling was observed when multiple devices were connected. Due to system limitations and time constraints, the problem was addressed by plugging earphones into each device. The use of Bluetooth microphones successfully resolved the issue by capturing and outputting audio more effectively.

Scalability and Generalization of the System for Efficient Material Creation and Simulated Learning

Under a 5G network, all perspectives—nurse, patient, and 360-degree—were streamed at approximately 30 fps, allowing for detailed visuals such as veins to be clearly displayed during instruction. To promote system generalization, network connectivity was shifted from RICOH Remote Field (JPY 3,917,500 for 120 users/50 hours, or JPY 540,000 annually at minimum usage) to the more cost-effective Webex (free basic plan). Hardware costs were also minimized: smart glasses (VUZIX) can be operated with an annual license fee of JPY 59,000. While testing low-cost webcams (5MP for video, 20MP for still images) confirmed adequate resolution, they struggled to transmit moving images effectively. To ensure successful lesson implementation, securing HD or higher resolution and incorporating considerations for equipment setup, student placement, and video distribution into the lesson plan were found to be crucial.

Furthermore, to effectively promote DX and improve workflow, it was essential to

establish a leadership structure capable of planning, system development, and ongoing operational management.

Summary for Generalization

To generalize this system, the most important principle is to make it as affordable and simple as possible. Only when users perceive the system as convenient and begin using it regularly will its functionality and contribution to digital transformation (DX) be realized.

Perceived Convenience and Functional Continuity

System Performance (bps, dB, dpi) and Challenges

In this study, the streaming speeds were approximately 1.5–3 Mbps for the nurse's perspective, 1.5 Mbps for the patient's perspective, and 5 Mbps for the 360-degree perspective. These speeds were sufficient under standard internet conditions. The frame rate (fps) ranged from 10 to 15 fps, but 30 fps is preferable for clearer technical videos—especially when distinguishing fine structures like veins. The 360-degree camera consistently maintained 30 fps, showing better performance in wide-angle views and confirming its effectiveness.

Streaming Delays During Multi-School Online Classes

During the first and second sessions streamed from Hamada Medical Center Nursing School, there was a slight delay with frame rates dropping to 7 fps and a maximum latency of 0.4 seconds. In the third session, streamed from Zentsuji Nursing School, the frame rate was lower due to device limitations but remained stable. Across all perspectives (nurse, patient, 360-degree), the average delay was 0.1 to 0.3 seconds. When both schools upgraded to 5G (downlink max 20 Gbps / uplink max 10 Gbps), delays were virtually eliminated, and both schools' survey results showed no significant differences in video quality.

However, audio presented challenges. While interactions via Interactive Whiteboards (IWB) were stable, audio howling occurred when multiple student devices were connected simultaneously. This issue was especially notable in the client school. In the fourth session (single school only), a stable 30 fps was maintained, and howling was resolved by using earphones plugged into each device or via Bluetooth microphones.