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Systematic Review of Clinical Reasoning in Technology-Enhanced Nursing Education

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Abstract: Clinical reasoning is a core competence in nursing education. It helps nursing students collect patient cues, interpret clinical information, make safe decisions, and reflect on nursing actions. In recent years, technology-enhanced learning has been widely used in nursing education, including simulation, virtual simulation, virtual patients, online learning, virtual reality, and artificial intelligence-supported learning. These methods may provide safe, repeatable, and interactive learning contexts for students to practise clinical reasoning before entering real clinical settings. This systematic review aims to summarize current evidence on clinical reasoning in technology-enhanced nursing education. The review focuses on three questions: what technologies have been used, how these technologies support clinical reasoning, and what problems still exist in current research. The reviewed literature shows that simulation-based learning and virtual simulation are the most common approaches. These methods can improve students' clinical reasoning, knowledge retention, self-efficacy, confidence, and satisfaction. Structured debriefing and reflection are important mechanisms that link technology use with reasoning development. However, current studies still have limitations, such as small samples, short intervention periods, inconsistent outcome measures, and limited long-term follow-up. Future research should use stronger designs, clearer theoretical models, and more direct measures of clinical reasoning.

1. Introduction

Clinical reasoning is one of the most important abilities for nurses. It refers to the process by which nurses collect information, notice patient changes, interpret clinical cues, make decisions, take action, and evaluate outcomes. In nursing practice, weak clinical reasoning may lead to delayed judgment, unsafe care, and poor patient outcomes. Therefore, nursing education must help students develop clinical reasoning before they enter real clinical practice.

Clinical reasoning is closely related to clinical judgment, decision-making, critical thinking, and problem solving. Although these concepts are not exactly the same, they are often used together in nursing education research. Tanner proposed a well-known model of clinical judgment, including noticing, interpreting, responding, and reflecting [1]. This model shows that nurses do not only apply

knowledge mechanically. They also use experience, context, patient information, and reflection to make judgments. Levett-Jones and colleagues further proposed the "five rights" of clinical reasoning: collecting the right cues, taking the right action, for the right patient, at the right time, and for the right reason [2]. These models have become important theoretical bases for teaching clinical reasoning in nursing education.

Traditional nursing education often depends on classroom teaching and clinical placement. However, clinical placement alone may not provide enough chances for students to practise reasoning. Real clinical settings are complex, unpredictable, and sometimes risky. Students may not have enough opportunities to manage high-risk cases. Teachers may also find it difficult to observe and assess students' reasoning process directly. Therefore, nursing education has increasingly used technology-enhanced methods to create safe and repeatable learning environments.

Technology-enhanced nursing education includes high-fidelity simulation, virtual simulation, virtual patients, computer-based case learning, online learning platforms, virtual reality, and more recently artificial intelligence-supported learning. These technologies can present clinical cases in a structured way. Students can assess patient conditions, make decisions, receive feedback, and reflect on their actions. In this way, technology may help students move from passive knowledge learning to active reasoning practice.

The rapid development of digital education after the COVID-19 pandemic further increased the use of virtual simulation and online clinical learning. Sim et al. reviewed virtual simulation in nursing and found that virtual simulation can support clinical reasoning development among nurses and nursing students [3]. Padilha et al. conducted a randomized controlled trial and reported that clinical virtual simulation improved knowledge retention, clinical reasoning, self-efficacy, and learning satisfaction [4]. These findings suggest that technology-enhanced learning has clear value for clinical reasoning education. However, the evidence is still uneven. Different studies use different technologies, different teaching designs, and different assessment tools. Therefore, a systematic review is needed to summarize the current research and identify future directions.

2. Literature review

2.1 Clinical reasoning and clinical judgment in nursing education

Clinical reasoning is not a simple linear process. It includes both analytic and intuitive thinking. Beginners often depend more on rules, checklists, and textbook knowledge. Experienced nurses can recognize patient patterns more quickly because they have more clinical experience. Nursing students are still developing their ability to connect theoretical knowledge with clinical situations. Therefore, teaching clinical reasoning requires more than lectures. Students need case-based practice, feedback, reflection, and repeated exposure to patient problems.

Tanner's clinical judgment model is widely used in nursing education [1]. The model explains how nurses notice relevant patient cues, interpret the meaning of these cues, respond through nursing actions, and reflect during and after action. Lasater later developed the Lasater Clinical Judgment Rubric based on Tanner's model [5]. This rubric provides a structured tool for assessing students' clinical judgment in simulation-based learning. It has been widely used in nursing education because it makes clinical judgment more observable and measurable.

Levett-Jones et al. also emphasized that clinical reasoning is central to patient safety [2]. Their model highlights that nurses must collect the right information and take the right action at the right time. This view is especially important in acute and high-risk care. For nursing students, failure to notice early signs of deterioration may lead to unsafe care. Therefore, clinical reasoning education should focus not only on knowledge but also on cue recognition, prioritization, decision-making, and timely response.

2.2 Simulation-based learning and clinical reasoning

Simulation-based learning is one of the most widely used approaches in nursing education. It allows students to practise clinical care in a safe setting. Students can make mistakes without harming real patients. They can also repeat the same scenario until they understand the reasoning process. High-fidelity mannequins, standardized patients, and scenario-based simulation are common forms of simulation.

Hayden et al. conducted the NCSBN National Simulation Study and found that high-quality simulation could replace part of traditional clinical hours in prelicensure nursing education without reducing educational outcomes [6]. This study provided strong support for the use of simulation in nursing education. Simulation is especially useful for clinical reasoning because it places students in realistic situations where they must observe, judge, act, and reflect.

However, simulation itself does not automatically improve reasoning. The quality of scenario design, teacher guidance, feedback, and debriefing is very important. Dreifuerst found that Debriefing for Meaningful Learning helped nursing students develop clinical reasoning after simulation [7]. Debriefing allows students to explain their thinking, compare actions with evidence, and identify gaps in judgment. Therefore, reflection is a key bridge between simulation experience and reasoning development.

2.3 Virtual simulation and digital learning

Virtual simulation has become more important in nursing education. It uses digital cases, virtual patients, videos, animations, or interactive platforms to present clinical problems. Compared with traditional simulation, virtual simulation is often more flexible and less limited by space, equipment, and teacher availability. Students can use it repeatedly and sometimes learn at their own pace.

Padilha et al. showed that clinical virtual simulation had positive effects on nursing students' knowledge retention, clinical reasoning, self-efficacy, and satisfaction [4]. This finding is important because it suggests that virtual simulation can support not only knowledge learning but also higher-level reasoning. Sim et al. also reviewed virtual simulation studies and found that effective virtual simulation usually includes clear learning objectives, realistic scenarios, active decision-making, feedback, and reflection [3].

Virtual simulation may help clinical reasoning in several ways. First, it provides authentic patient situations. Second, it allows students to practise cue collection and decision-making. Third, it gives immediate feedback. Fourth, it supports repeated practice. These features are useful for students who have limited access to real clinical cases.

However, virtual simulation also has limitations. Some studies rely heavily on self-reported confidence or satisfaction rather than direct assessment of reasoning. Some interventions are short and do not show long-term effects. In addition, not all virtual simulations are equally effective. Poorly designed digital cases may become simple screen-based exercises rather than true reasoning practice.

2.4 Artificial intelligence and emerging technologies

Artificial intelligence is an emerging direction in technology-enhanced nursing education. AI may support clinical reasoning education through virtual patients, adaptive feedback, automated assessment, learning analytics, and personalized learning pathways. For example, AI-supported systems may generate patient dialogues, provide formative feedback, or analyze students' clinical actions.

The main advantage of AI is that it may provide more flexible and individualized learning. Students can interact with virtual patients many times. The system can respond to student decisions

and provide feedback. This may help students practise reasoning in a more active way. However, AI-supported clinical reasoning education is still at an early stage. Many studies focus on feasibility, acceptance, or user experience rather than strong evidence of learning outcomes.

There are also ethical and practical issues. AI systems may provide inaccurate information. They may also create privacy risks if student data are collected. Teachers still need to check the quality of AI-generated cases and feedback. Therefore, AI should not replace nursing teachers. It should be used as a support tool within a clear pedagogical design.

3. Methods

This review used a systematic review framework to examine studies on clinical reasoning in technology-enhanced nursing education. The review focused on studies that discussed nursing students, nurses, or nursing education programs and used technology-enhanced learning to support clinical reasoning, clinical judgment, or clinical decision-making.

The main search concepts included “clinical reasoning,” “clinical judgment,” “clinical decision-making,” “nursing education,” “nursing students,” “simulation,” “virtual simulation,” “virtual patient,” “technology-enhanced learning,” “online learning,” “virtual reality,” and “artificial intelligence.” Studies were considered relevant if they met the following criteria: first, the study focused on nursing education or nurse training; second, the intervention involved a technology-enhanced learning method; third, the outcome or discussion included clinical reasoning, clinical judgment, decision-making, or related competencies; fourth, the study was published in a peer-reviewed academic source.

Studies were excluded if they were not related to nursing education, did not involve technology-enhanced learning, or only discussed general academic performance without connection to clinical reasoning. Both empirical studies and high-quality reviews were considered, because this field includes different types of evidence. Key information was extracted from the included literature, including author, year, technology type, participants, learning design, outcome measures, and main findings.

The synthesis followed a narrative approach. The studies were grouped by technology type and pedagogical function. The main categories were simulation-based learning, virtual simulation, structured debriefing and reflection, and AI-supported or emerging digital learning. Because studies used different designs and outcome measures, a meta-analysis was not conducted.

4. Results

4.1 Main technologies used in the field

The reviewed literature shows that simulation-based learning is the most mature technology-enhanced approach in nursing clinical reasoning education. Traditional simulation, high-fidelity simulation, and standardized patient simulation are commonly used. These methods help students experience patient care situations and practise reasoning in a safe environment.

Virtual simulation is another important approach. It has developed quickly because it can be used online and can reduce the pressure of limited clinical placement. Many virtual simulation studies use interactive patient cases. Students need to collect data, identify problems, choose interventions, and receive feedback. Evidence suggests that virtual simulation can improve clinical reasoning and related outcomes [3,4].

Virtual reality and AI-supported learning are newer directions. These technologies may provide more immersive and adaptive learning experiences. However, compared with simulation and virtual simulation, the evidence base is still smaller. Many studies remain exploratory.

4.2 Effects on clinical reasoning and related outcomes

Most studies report positive effects of technology-enhanced learning on clinical reasoning or related learning outcomes. Simulation can improve students' ability to assess patient conditions, identify priorities, and make care decisions. Virtual simulation can also improve knowledge, reasoning, self-efficacy, and learning satisfaction [4]. These effects may be stronger when the learning design includes active decision-making and feedback.

However, the strength of evidence differs across studies. Some studies use validated tools, such as the Lasater Clinical Judgment Rubric [5]. Other studies use teacher-made tests or self-report scales. Self-confidence and satisfaction are useful outcomes, but they cannot fully show whether students' reasoning has improved. Therefore, future studies should use more direct and valid measures of clinical reasoning.

4.3 Pedagogical mechanisms

The findings suggest that technology supports clinical reasoning through several mechanisms. First, technology creates realistic clinical contexts. Students can connect theoretical knowledge with patient situations. Second, it supports active learning. Students must make decisions rather than only listen to lectures. Third, it allows repeated practice. Students can experience similar cases many times and gradually improve their reasoning. Fourth, it provides feedback and reflection.

Debriefing is especially important. Simulation without reflection may become only a technical activity. Debriefing helps students explain why they made certain decisions and how they could improve. Dreifuerst's work shows that meaningful debriefing can foster clinical reasoning development [7]. Therefore, the teacher's role remains important even in technology-rich learning environments.

4.4 Research gaps

Although the field has grown, several gaps remain. First, many studies have small samples and short intervention periods. It is difficult to know whether the learning effects can last over time. Second, outcome measures are inconsistent. Different studies use different tools, making comparison difficult. Third, many studies measure confidence, satisfaction, or perceived learning rather than actual reasoning performance. Fourth, the theoretical basis of some interventions is not clear. Technology is sometimes used because it is new, not because it is connected to a clear learning theory.

Another gap is the limited study of AI-supported clinical reasoning education. AI has great potential, but current evidence is still immature. Future studies should examine whether AI can truly improve reasoning quality, not only whether students like using it. Issues such as accuracy, bias, data privacy, and teacher supervision must also be considered.

5. Discussion

This review shows that technology-enhanced learning has become an important part of clinical reasoning education in nursing. The field has moved from simple simulation use to more reasoning-oriented instructional design. The most effective learning designs do not only present clinical cases. They require students to notice cues, interpret information, make decisions, receive feedback, and reflect on their actions.

Clinical judgment theory remains the intellectual foundation of this field. Tanner's model provides a clear structure for understanding how nurses think in practice [1]. Lasater's rubric helps teachers assess clinical judgment in simulation [5]. Levett-Jones' "five rights" model connects reasoning with

patient safety [2]. These models should continue to guide the design of technology-enhanced learning.

Digital and AI-supported learning is an important future direction. Virtual simulation has already shown positive effects, especially when it includes realistic cases and structured feedback [3,4]. AI may further support personalized practice and automated feedback. However, the evidence for AI in nursing clinical reasoning education is still developing. Researchers should avoid overstating its value before stronger evidence is available.

The role of teachers also needs attention. Technology cannot replace teacher guidance. Teachers design scenarios, guide learning, conduct debriefing, and help students reflect on clinical decisions. In this sense, technology is not the center of clinical reasoning education. The center is still the development of students' professional thinking.

6. Conclusion

Clinical reasoning is a key competence in nursing education, and technology-enhanced learning provides useful ways to support its development. Simulation-based learning and virtual simulation are the most widely studied approaches. Current evidence suggests that these methods can improve clinical reasoning, knowledge retention, self-efficacy, confidence, and satisfaction. Structured debriefing and reflection are important mechanisms that help students transform simulation experience into reasoning ability.

However, the field still has several limitations. Many studies use small samples, short interventions, and different assessment tools. Some studies depend too much on self-reported outcomes. Evidence on AI-supported clinical reasoning education is still early. Future research should use stronger study designs, longer follow-up periods, validated assessment tools, and clearer theoretical frameworks. More attention should also be given to how technology, teachers, feedback, and reflection work together to support nursing students' clinical reasoning.

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