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Short Communication

Cognitive Load Measurement, Worked-Out Modeling, and Simulation

Jayne Josephsen, EdD, RN, CCCTM, CHSE, CHPN*

School of Nursing, Boise State University, Boise, ID, USA

KEYWORDS
simulation;
cognitive load theory;
measurement;
worked-out example;
modeling

Abstract: Using a cognitive load theory framework, this study investigated implementation of a worked-out modeling (WOM) prebriefing intervention on postsimulation knowledge acquisition and cognitive load experienced. A quasi-experimental quantitative design was used with a convenience sample of 61 senior-level nursing students who had previously participated in a simulation. The treatment group received the WOM intervention before simulation participation, and the control group received the usual presimulation interventions. A presimulation and postsimulation knowledge survey and a cognitive load measurement tool were administered after the simulation. Data indicated increased knowledge related to falls and situation, background, assessment, and recommendation in the treatment group and suggested that the treatment group experienced more intrinsic and germane load and less extraneous load. Overall, the cognitive load measurement tool was found reliable, although extraneous load measurement had poor reliability. In conclusion, further research concerning WOM is warranted, as is continued development and research concerning the cognitive load measurement tool.

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Background

Nursing was founded in an apprenticeship educational model, in which a student was paired with an expert nurse who provided supervision, support, and instruction. In this model, the student learned through demonstration, observation, and imitation while engaging in dialog and coaching with the expert nurse concerning skills, interventions, and critical thinking processes (Baltzersen, n.d., Ch. 3). The complex simulation environment often does not provide this benefit of the ‘‘expert’’ nurse exemplar that is seen in the historical apprenticeship and current clinical model of nursing education.

Multiple concepts are presented in simulation, requiring the student to analyze and filter relevant information, while engaging in critical reasoning to guide interventions in a complex setting. Cognitive load theory (CLT) aptly applies to complex learning situations such as simulation, providing a range of interventions that positively affect student learning. Clark, Nguyen, and Sweller (2006) identified one such intervention as the worked-out example, which provides task completion demonstration before task performance, effectively reducing cognitive load,

* Corresponding author: jaynejosephsen@boisestate.edu (J. Josephsen).

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increasing learning, and assisting critical reasoning development. This study's aim was to evaluate the application of worked-out modeling (WOM), developed by the author, based on the CLT worked-out example in simulation. WOM is defined as "the modeling of a skill or procedure by a nurse paired with verbal and gestural description of critical thinking processes and pathophysiological connections to the content to be used for imitation, comparison, or representation of a standard of practice" (Josephsen, 2015, p.16).

Key Points

- Worked-out modeling provides an example of application of psychomotor skills, critical thinking processes, and pathophysiological connections to content.
- Using Worked-out modeling as a presimulation activity can alleviate inherent cognitive load burden and promote learning.
- Measurement of cognitive load experienced in simulation needs continued development.

Theoretical Framework

CLT focuses on understanding how a student's cognitive architecture affects learning. Cognitive architecture is composed of a variety of information-processing components including working memory, long-term memory, schema, and cognitive load. Working memory is finite, used during initial learning, and affected by cognitive load. Working memory is generally thought to be limited to processing up to seven elements or pieces of information at one time. This amount decreases as the need for analysis and problem solving increases. Long-term memory stores knowledge that can be situationally retrieved, enhancing working memory function (Plass, Moreno, & Brunken, 2010). Integral to long-term memory is the development and use of schema (a framework or model, much like a clinical algorithm) that assists in organizing information and guiding solutions related to specific content.

Cognitive load consists of three distinct types, namely, extraneous, intrinsic, and germane. Extraneous load involves instructional aspects that are not related to learning outcomes and taxes working memory and learning ability. Intrinsic load consists of materials or activities essential to learning. Content that is complex or has multiple conceptual elements contains higher intrinsic load, impacting working memory and learning capacity. Finally, germane load relates to the ability to integrate new knowledge into schemas that are used in future practice. These types of load have an additive effect, and once the working memory is exceeded, learning is negatively impacted. Simulation generally contains many elements/concepts and dynamic conceptual interactivity that contributes to high extraneous and intrinsic load, limiting working memory, decreasing germane load, and potentially diminishing learning (Fraser, et al., 2012, p. 1,056).

Using WOM as a presimulation intervention may alleviate inherent cognitive load issues. WOM provides guidelines for addressing the scenario and identification of visual cues and verbal representations of problem areas and highlights relevancy of identified concepts/elements to the final scenario solution. Renkle and Atkinson (2003), p. 17, suggest that novice learners often have insufficient domain-specific knowledge when presented with new problem situations, causing reliance on general problem-solving tactics. This can increase intrinsic load, tax working memory, and affect learning. Before simulation, if the student is provided with an example solution, explanation of how to approach the scenario, and the critical thinking processes used by an expert nurse, concepts can be connected and germane load can be enhanced. This assists in meeting learning outcomes and enables schema creation for transfer to future practice (Van Merrienboer, Kirschner, & Kester, 2003, pp. 6-7).

WOM use supports simulation outcomes related to clinical judgment and reasoning, critical thinking, and psychomotor skill development. Providing WOM presimulation ideally assists the student to focus on important simulation elements, identify critical thinking processes, distinguish data relevancy, select appropriate interventions, and assist in analyzing patient outcomes. In addition, the use of WOM provides the student with a proficient example of application of psychomotor skills and allows for the expert nurse to discuss examples of how to contextually adapt skills if needed (Josephsen, 2015).

Sample

A quasi-experimental quantitative research design was used with a convenience sample of 61 senior nursing students with previous simulation experience. Students were divided into eight groups of seven to eight students each, with four treatment groups receiving WOM and four control groups not receiving WOM. There were 27 students (21 female and six male students) in the treatment group and 34 students in the control group (30 female and four male students).

Methods

A multipatient simulation focusing on delegation and decision-making was selected for the study. This simulation was felt to be appropriate as it involved clinical reasoning and prioritization skills, which require development and use of schema. Both the treatment and control groups performed the usual presimulation reading assignment. The control group went through the usual prebriefing, orientation, and question/answer time before simulation participation. The treatment group also had a prebriefing,