THEORETICAL FOUNDATIONS OF EDUCATIONAL STRATEGIES USED IN E-LEARNING ENVIRONMENTS FOR DEVELOPING CLINICAL REASONING IN NURSING STUDENTS: A SCOPING REVIEW

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Abstract

E-learning environments expand opportunities for the use of educational strategies that may contribute to the development of clinical reasoning in nursing students. The purposes of this scoping review were the following: 1) to map the principles of cognitive companionship and the theoretical foundations underlying the design and implementation of educational strategies used in e-learning environments for developing clinical reasoning in nursing students; and 2) to identify the types of educational strategies used in e-learning environments for developing or assessing clinical reasoning in nursing students. A scoping review was conducted and was based on the Joanna Briggs Institute Framework. Bibliographical databases were searched for studies published between January 2010 to July 2017. Out of 1,202 screened articles, 18 met eligibility criteria and were included in this review. Principles of cognitive companionship in e-learning environments provide key clues from a learning support perspective, such as integrated feedback, interactive group discussion, gaming, and questioning. However, theoretical foundations underlying educational strategies in e-learning environments are poorly documented and insufficiently associated with cognitive learning models. E-learning environments must have solid theoretical foundations to provide support for the development of CR in nursing students.

Keywords: cognition; judgment; clinical decision-making: nursing education

Highlights

- Explicit links between theoretical foundations and education strategies are needed
- Cognitive companionship involves supervision for developing clinical reasoning
- Pedagogical use of solved examples and role models should be explored in nursing

Background

E-learning environments are increasingly used in undergraduate nursing programs, and this field of educational research is expanding quickly (Fontaine et al., 2017; Voutilainen et al., 2017). E-learning environments involve the use of electronic technologies to support the learning process (Clark and Mayer, 2016). Advantages of integrating e-learning environments in education programs have been expressed, such as increased student satisfaction and motivation, as well as improved accessibility (Kala et al., 2010). These environments, through the integration of educational strategies such as clinical simulations, interactive games, and virtual patients, may serve to represent quasi-authentic situations of clinical practice. However, while educational strategies within e-learning environments appear to be beneficial for learning, their contribution to the development of clinical reasoning (CR) in nursing students remains unclear.

The development of CR in nursing students is a priority for higher education institutions. CR is defined as "a complex cognitive process that uses formal and informal thinking strategies to gather and analyze patient information, evaluate the significance of this information and weigh alternative actions. Core essences of this concept include cognition, metacognition and discipline-specific knowledge." (Simmons, 2010, p. 1155). Making clinical decisions in contexts of uncertainty and complexity has become the norm for current nursing practice. This reality puts the newly graduated nurse in situations in which they have to demonstrate sound CR from the beginning of their professional practice. In addition, the increasingly scarce availability of clinical placement environments for undergraduate nursing

programs, the diversity of care situations encountered, and the fast pace of clinical care encourage higher education institutions to consider complimentary educational strategies, such as the ones found in e-learning environments (Smith et al., 2010). The challenge for higher education institutions is therefore to design and implement educational strategies in e-learning environments favorable to the development of CR in undergraduate nursing students.

More specifically, it is unclear which educational strategies in e-learning environments can foster nursing students' *cognitive apprenticeship of CR*, i.e., the process through which they articulate knowledge, reflect on actions, and ultimately develop CR. In other words, it is still unclear how educational strategies within e-learning environments use principles of cognitive companionship (CC) to support the development of CR (Figure 1). Developed by Collins et al. (1989), CC aims to create an optimal social, dialogical and pedagogical interaction between students and educators, where the latter use educational strategies to foster students' practice of reflection (Collins, 1991; Collins et al., 1989) and thus, the acquisition of essential cognitive and metacognitive skills for the development of CR (Simmons, 2010). These educational strategies used by the educator can be related to coaching, scaffolding, modelling, and fading. The principles of CC stipulate that offering a cognitive support adapted to students' level, as well as explicit teaching moments combining questioning, supervision, and constructive feedback, are essential in the development of CR (Collins, 1991; Collins et al., 1989; Frenay and Bédard, 2004). In addition, CC involves four educational strategies that can be used by teachers. First, with *coaching,* the teacher observes

the student and offers hints, feedback or reminders. Second, with *scaffolding*, the learner is supported during the learning process according to its current competence level, and activities are organized to assist the student progressing to the next level. Third, *modelling* involves the teacher *thinking out loud* to make explicit his or her cognitive processes, so that the student can perceive some subtleties of the CR processes and learn. Finally, with *fading*, learning support is gradually removed until the student is able to reason well by itself (Collins, 1991; Collins et al., 1989; Deschênes et al., 2018; Frenay and Bédard, 2004).

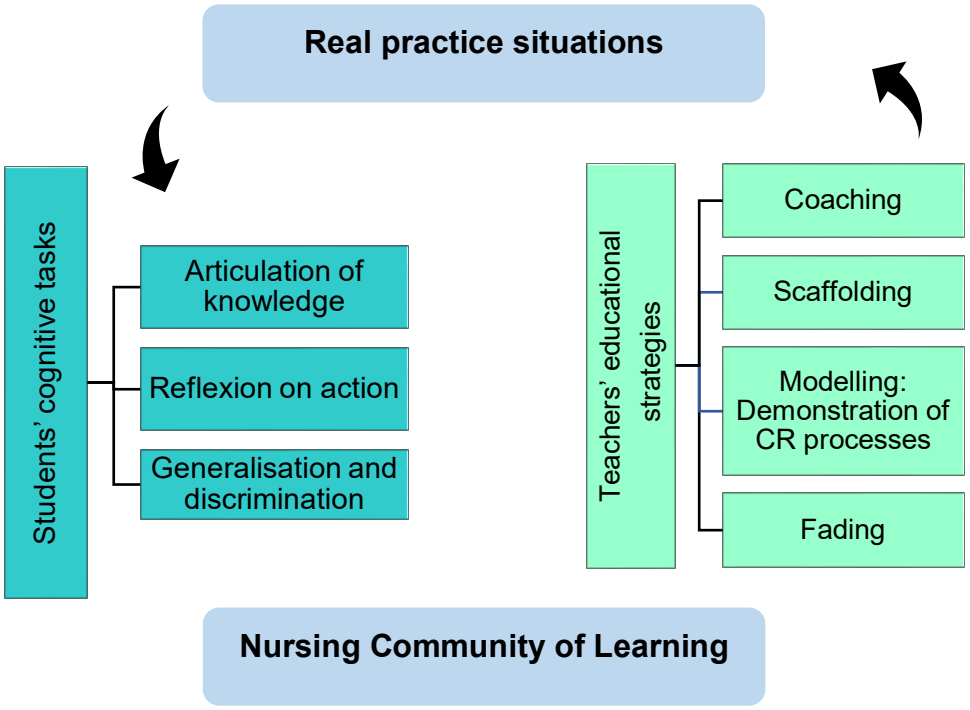

Figure 1 : The principles of cognitive companionship for the development of clinical reasoning (CR) in Nursing Education

Deschênes et al. (2018). Adapted from Frenay and Bédard (2004), p.151

While CC principles may be beneficial for developing CR in nursing students, many questions remain regarding *if* and *how* these principles are considered in the design and implementation of educational strategies in e-learning environments. Thus, examining the theoretical foundations underlying these educational strategies, as well as the educational strategies themselves, would allow characterization and mapping the principles of CC found in e-learning environments. In addition, as CR is traditionally assessed by methods well-suited for face-to-face assessment such as think-aloud methods or observation grids (Chua, 2017; Crowe et al., 2018; Forsberg et al., 2014), it remains unclear how assessment methods of CR have been translated to e-learning environments.

Scoping review aims

The primary aim of this scoping review was to map the principles of CC and the theoretical foundations underlying the design and implementation of educational strategies used in e-learning environments for developing CR in nursing students. The secondary aim was to identify the types of educational strategies used in e-learning environments for developing or assessing CR in undergraduate nursing students.

Methods

A scoping review based on the Joanna Briggs Institute (2015) methodological framework was conducted. A scoping review is a type of systematic review aimed at providing an interpretive and comprehensive overview of the evidence related to key concepts underpinning a topic area (Joanna Briggs

Institute, 2015). It also aims to identify the extent of current knowledge to validate what is known and what remains to be researched (Davis et al., 2009; Joanna Briggs Institute, 2015).

Eligibility criteria

To determine eligibility criteria and build the literature search strategy, we used the PCC method (P: population, C: concept, C: context). In terms of population, this scoping review focused on nursing students in undergraduate programs (giving access to registration as a nurse/Registered nurse [RN]). The central concept of this scoping review was the educational strategies that are integrated in e-learning environments to foster the development of CR. An educational strategy can refer to any strategy or component than can support learning within an e-learning environment. CR is viewed here as a cognitive process that guides data collection, analysis, and interpretation in clinical situations to formulate a judgment and lead to decision-making (Simmons, 2010, p. 1155). As such, concepts such as clinical judgment and decision-making are often used in a substitutional or interchangeable way amongst authors while referring to CR (Thompson et al., 2013; Victor-Chmil, 2013). Therefore, all these concepts have been considered in the literature search. Finally, e-learning environments represent the context studied. They are distinguished from traditional learning environments by the absence of face-to-face contact with an educator and the use of an electronic device specifically intended to support learning, such as a smartphone, a tablet or a computer. Courses within an e-learning environment can be designed for self-study (asynchronous) or taught by an educator in real time

(synchronous) (Moore et al., 2011; Voutilainen et al., 2017). All papers presenting the development, or the empirical evaluation, of an e-learning environment were considered for inclusion.

Literature search

The literature search strategy was developed with the assistance of a librarian. It used a combination of keywords and descriptors related to three concepts (undergraduate nursing students, e-learning environments, clinical reasoning). The CINAHL search strategy was developed first [see Supplementary file 1]. The descriptors and keywords of this search strategy were then translated for the other bibliographic databases. In total, six bibliographic databases were searched in July 2017: CINAHL, EMBASE, ERIC, PsycINFO, PubMed and Web of Science. A first preselection, based on the reading of the title and the abstract, was conducted by the first author (MFD). An in-depth reading of these articles was then conducted independently by two authors (MFD, GF, MC, or KBDS). This operation removed articles that did not meet the eligibility criteria of this scoping review: 1) articles whose population was not undergraduate nursing students; 2) articles not addressing educational strategies aimed at developing or evaluating CR; 3) articles whose educational strategies were not within an e-learning environment; and 4) non-empirical articles. Additional articles were hand-searched through the reference list of included articles, and by a prospective consultation of the literature that cited the included articles. Disagreements over the selection of articles were resolved through discussion and consensus. When a disagreement

persisted, a third author (JG) was involved. Reference management was done using EndNote © software, version 8.0.

Data extraction

The following elements were extracted and analyzed by the first author in a reading matrix: 1) general information about the study (e.g., year of publication, authors, country of the main affiliation of the primary author); 2) research design and purpose of the study; 3) educational strategy used in the e-learning environment for developing CR; 4) principles of CC and the theoretical foundations underlying the design and implementation of educational strategies; and 5) main results reported and authors' recommendations regarding the design and implementation of educational strategies. These elements analyzed were validated by four authors of this review.

Results

Article flow

The search strategy allowed for the identification of 874 unique references. In addition, 4 references were identified through other sources. After screening and full text review, a total of 18 articles were found to be eligible for this review (see **Figure 2**).

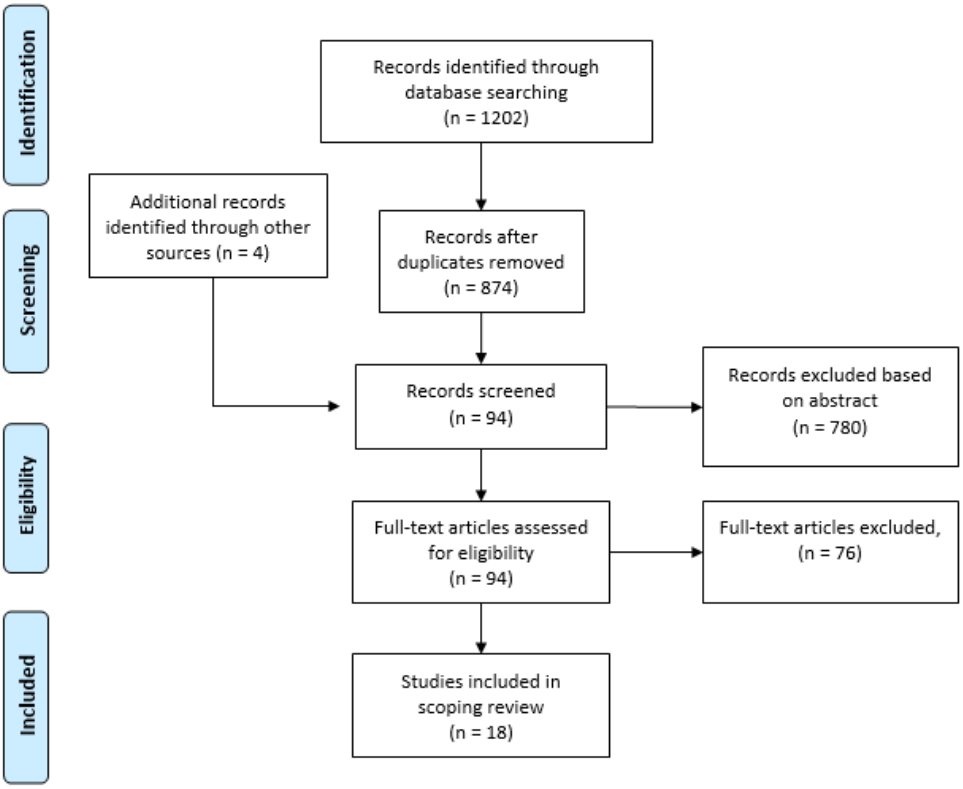

Figure 2: Flow chart

The studies (Table 1) used a variety of research designs that focused on the appreciation by the nursing students of the educational strategy, the evaluation of the development of CR, and the design and implementation itself of educational strategies without any empirical evaluation. Results were mixed regarding the effectiveness of these educational strategies for developing CR. Regarding the aims of this scoping review, the first section of the results maps the principles of CC and the theoretical foundations underlying the design and implementation of educational strategies. The second section of the results describes the educational strategies as well as the methods to assess the development of this competency.

Authors / Year / Country	*Methods and objective(s)*	*Educational strategy*	*Principles of cognitive companionship used*	*Reference to a theoretical model of CR*	*Results and Recommendations*
Chan et al. (2016) **China**	Mixed-method study. To examine the learning experience using face-to-face or online problem-based learning.	Problem-based learning.	Online discussion forums including facilitation and follow-up of discussions by the educator. Questions regularly asked by the educator.		No difference between the two approaches on CR (t = 0.358, p = .721), measured using a self-reported questionnaire. It is suggested to lead discussions in synchronous mode to provide immediate feedback.
Cobbett et al. (2016) **Canada**	Quasi-experimental study. To explore understanding and application of knowledge as well as critical thinking.	Online tutorials including case studies.	All education modules had to be finalized to obtain certification. Incorporation of online discussion groups, wikis, quizzes, and reflective journals.		Both groups demonstrated statistically significant differences in the pretest as compared to the post-test, but the experimental group differences were larger and highly significant (t = -2.64, p = .000). The scores were assessed using a multiple-choice questionnaire. The presence of the educator and active participation are

					essential for any form of online education.
Forsberg et al. (2011) **Switzerland**	Pilot study. To evaluate students' opinion regarding the development and evaluation of CR. To explore the possibilities and challenges of implantation.	Virtual patient.	The feedback is part of the module according to the decision-making choices of the student and his success in resolving situations. Availability of the educator in person or by phone.		Positive appreciation of students. The use of virtual patients makes it possible to capture the digital footprint in the students' decision-making. Its use requires further research, especially in terms of a certificated evaluation of CR.
Hoffman et al. (2011) **Australia**	Qualitative study. To describe the students' appreciation of the digital strategy for the development of CR.	Computerized interactive decision support.	Evolutionary learning sequence determined from a CR model. The success of a learning sequence is necessary before moving on to the next, regardless of the number of trial-and-error sessions.	Levett-Jones et al. (2010)'s CR model.	Positive student satisfaction (79%) for the development of CR while some complain about the lack of real contact with the educator. Immediate feedback to the student is suggested to maximize their participation and motivation.

Hsu and Hsieh (2014) **China**	Correlative study. To examine the influence of demographics, participation and performance on metacognition.	Case studies of ethical dilemmas including videos.	Hybrid e-learning formula: Combined use of face-to-face and e-learning. Use of online chatrooms.		The results show significant associations between the frequency of online chatting and students' metacognitive abilities ($p < 0.02$). These abilities were measured by the Metacognition Scale, a tool adapted by Hsu (2010).
Johnsen et al. (2016) **Norway**	Pilot study. To appreciate the level of feasibility and acceptability related to the use of serious games in the development of CR.	Serious game.	Integration of various questions. Feedback is included to demonstrate actions that are considered correct, thanks to an integrated link. Point system integrated into the serious game. A student must finalize a task before continuing the activity.	The Clinical Decision-Making Model of O'Neill et al. (2005).	Positive appreciation of students. However, some suggested more feedback to validate why one answer is "fairer" than another. It is suggested to form groups with a teacher present at the activity or to provide a debriefing after the end of the game. The coherence between theoretical support and the development of serious games is essential.

Koivisto et al. (2016) **Finland**	Descriptive Study To explore the students' CR learning model.	Serious game.	Immediate feedback and related decision-making choices of the student are integrated. Validation of the performance according to the reactions of the patient as well as from the integrated comments. The student can complete the game alone or against another player.	Levett-Jones et al. (2010) 's CR model.	Positive appreciation of students. Serious game design must be developed considering the cyclical and dynamic process of CR. The integration of play in the classroom is suggested to foster discussion.
Koivisto et al. (2018) **Finland**	Research-development study. To describe the development process and generate principles for serious game design.	Serious game.	Feedback introduced within the game by a color system. This allows the student to validate the correctness of his or her decision-making. The iterative learning is optimized.	Levett-Jones et al. (2010) 's CR model.	Serious game design requires iterative cycles of analysis, design, development, and enhancement through the collaboration of researchers, educators, students, and game designers. Game design must be built around the process of CR in an iterative and systemic perspective and not in a linear fashion.

LeFlore et al. (2012) **United States**	Randomized control trial To compare and measure the acquisition and application of knowledge.	Virtual patient.	Feedback introduced into the interface by a system of color and faces simulating the adequacy or not of the student's decisions. Debriefing at the end of the session and individualized formative evaluation.	Significant difference in knowledge translation of the experimental group compared to the control group ($p = 0.001$), measured using an Objective Structured Clinical Examination (OSCE). The formative assessment generated during the activity and following the debriefing helps to optimize learning.
McCallum et al. (2011) **United Kingdom**	Descriptive study To explore students' decision-making when using the Second Life virtual environment.	Virtual patient.	Mentor is present during the activity to provide comments and advice to the student. Communication is established and necessary between peers to conduct the activity. Period of written reflection following the activity.	Most of the student decisions were "reactive" rather than proactive. Communication is an essential part of clinical decision-making. Typing rather than talking distracted the students. The form of communication used in digital environments can be a variable that influences the decision-making process.

Morey (2012) **United States**	Mixed experimental study To evaluate the effectiveness of animated pedagogical agents on critical thinking.	Animated pedagogical agent.	Use of questioning by animated pedagogical agents to solve problems and provide feedback. At the end of the activity, the students get an assessment of the expected answers in correlation with their answers.	Refers to 8 cognitive processes in the think aloud analysis: collect, review, relate, interpret, deduce, diagnose, act, and evaluate.	There was no significant difference between the two groups in the evaluation of critical thinking as measured by Anderson et al.'s Critical Thinking Process Test (CTPT) (2000). Analysis of thoughts by voice shows that Socratic-type questioning seems to help stimulate the critical thinking of the student.
Morris (2015) **United States**	Quasi-experimental study To measure the impact of the strategy on clinical judgment.	Computerized interactive decision support.	Possibility to see the consequence of the actions of the student. Formative assessment and use of questionnaires. Individualized feedback at the end of the sequence and the student can redo the complete sequence.	Clinical Model Judgment of Tanner (2006).	No statistically significant difference between the group scores, t = 0.846 (df, 48). Scores were measured using Lasater's *Lasater Clinical Judgment Rubric* © (LCJR) (2007). Feedback at the end of the sequence is necessary to allow self-regulation of student learning.

Oldenburg and Hung (2010) **United States**	Case study To describe the cognitive strategies used for problem solving.	Online problem-based learning.	Reflection on the next learning after each module Online discussion. Verbalization following the activity.	Critical Thinking Model of Garrison (1991).	Identify the learning objects, communicate the results and provide feedback to be integrated into the e-learning environment strategy. Increase educator participation in discussion forums and use solved examples.
Park (2013) Korea	Research-development study To describe the experience of developing a computer program and the degree of student appreciation.	Case studies of ethical dilemmas.	Various questioning tools are integrated. Visualization of the reasoning process to validate the consequences and compare it to alternatives. Reflective models of integrated experts. Allocation of points and discussion group following the activity.	Ethical Decision-Making Model of Park (2012).	82% of students recommend this tool as a complement to other educational activities. Accurate understanding of affective responses to ethical issues in an authentic setting is a limitation. Small group discussion is suggested following the activity.
Park et al. (2016) **Korea**	Quasi-experimental study To measure the impact of the strategy on	Computerized and face-to-face interactive decision support.	Hybrid e-learning formula: Combined use of face-to-face and e-learning environment.	Lee et al. (2008)'s adult problem-solving tool.	Statistically demonstrated improvement in the overall level of problem-solving ability ($t = 2.654$, $p = 0.10$), as measured

	feeling of self-efficacy, problem-solving ability and psychomotor skills.				by Lee et al. (2008)'s tool. Hybrid e-learning formula allows iteration of activities and self-directed learning.
Sadhuwong, Koraneekij, and Natakuatoong (2016) **Thailand**	Quasi-experimental study To measure students' CR.	Computerized and face-to-face interactive decision support.	Hybrid e-learning formula: Interactive support and reflective models of integrated experts. Feedback and discussion group. Formative assessment and iteration of learning.	Refers to 5 steps of CR: 1-Analyze; 2-Formulate hypotheses; 3- Collect and process information, 4-Make a judgment and 5- Review decisions.	Appreciation of cognitive processes modelling made possible by the observation of reflexive role models. The post-test score of the experimental group was significantly higher than their pretest score (mean = 73.07 ± 6.58 and 56.12 ± 9.97; p <0.001). The score was measured by a script concordance test.
Secomb et al. (2012) **Australia**	Randomized control trial To measure the effect of simulation activities on cognitive development.	Computerized interactive decision support.	Frequent and formulated clinical signs by the simulated patients are integrated into the software. At the completeness of the activity, participants receive feedback on		Lack of significant difference in cognitive development as assessed by Moore's Learning environment preferences Inventory (1989). Difficulties persist regarding the evaluation

			their performance and overall score.	tools to be used during the simulation.
Stanley and Latimer (2011) **Australia**	Descriptive study To assess the appreciation and relevance of serious games for decision-making learning, critical thinking and teamwork.	Serious game.	Use of serious games in class. Reiteration of learning outcomes and face-to-face tutoring. Discussion following the completeness of the scenarios, before the attribution of the points and the continuation to the other scenarios.	80-95% consider the game useful for the development of CR, critical thinking and leadership. These skills were measured using a self-reported questionnaire. The contribution of team play is to be considered to better prepare students for clinical practice.

Principles of cognitive companionship and theoretical foundations underlying the design and implementation of the educational strategies

In terms of support for learning, the educational strategies listed used a myriad of CC principles in diverse and creative means to ensure coaching, scaffolding and modelling. For example, the principle of coaching in CC was observed when the teachers offered feedback, questioned students and used diverse types of interactions. Some used automated and integrated feedback from the educational strategy, while others engaged in a dialogue through discussion forums or chatrooms. Formative assessments, educational activities or iteration and gamification modes of learning were also used to ensure scaffolding. Less commonly, the principle of modelling was used to make visible the CR processes used by experts in simulated situations (Park, 2013; Sadhuwong et al., 2016). Several researchers considered the advantage of using hybrid formulas that combine both the benefits of the Web and the benefits of the tangible presence of the educator or of a learning community (Cobbett et al., 2016; Hoffman et al., 2011; Hsu and Hsieh, 2014; Park et al., 2016; Sadhuwong et al., 2016). Table 1 also presents the theoretical foundations that underlie the educational strategies designed and implemented in e-learning environments. Some studies do not refer to a theoretical foundation, but they do state a cognitive or decision-making process.

Educational strategies used in e-learning environments for the development of nursing students' CR

The educational strategies used include the use of tutorials, case studies, problem-based learning, computerized interactive decision support, serious games, animated pedagogical agents, and virtual patients. Tutorials, case studies, problem-based learning,

and computerized interactive decision support are educational strategies that enable practice and decision-making in various situations of clinical practice. They also offer the use of certain online features such as forums or chatrooms, extensive use of database content, audio and video clips, computerized patient records, and more. Serious games offer various types of challenges, combined with gaming design elements (e.g., points, badges, hints, time pressure), that learners must face by using their knowledge and skills (Maheu-Cadotte et al., 2018; Salen et al., 2004). Pedagogical agents or virtual characters interact with the student by asking questions and providing comments on a series of case studies and by capturing the synchronized reading of the lips (Morey, 2012). They are distinct from avatars, associated with the use of virtual patients or serious games (Miller and Jensen, 2014). The use of a virtual patient refers to an immersive and interactive simulation where one integrates a patient's medical history, physical examination, laboratory and diagnostic tests as well as any other possible features to consider in the undertaking of a clinical situation in an environment simulating reality (Kilmon et al., 2010).

Discussion

There is no doubt that technological advancements are shaping the educational strategies in e-learning environments for developing CR in nursing students. In this scoping review, some principles of CC used in e-learning environments provide some key clues from a learning support perspective conducive to the development of CR in nursing students.

The relevance of a theoretical model to guide the development of nursing CR and educational strategies in e-learning environments

In some studies, we noted a lack of reference to theoretical foundations underlying the design and implementation of educational strategies. At other times, it was difficult to identify how these theoretical foundations helped to anchor the stages of nursing students' CR development. In this regard, some researchers have used a cognitive learning model of CR to effectively link the educational strategy designed to the critical stages of CR development. For example, the study by Hoffman et al. (2011) examined the correspondence between the Levett-Jones et al. (2010)'s CR model and the development of CR in nursing students. Interestingly, nursing students could not continue the education program if they did not pass a stage deemed necessary to the development of this competency. We also noticed this concern in serious games where the student was unable to progress in the e-learning environment without obtaining his or her badge of merit after completing a challenge (Johnsen et al., 2016; Koivisto et al., 2018; Koivisto et al., 2016; Stanley and Latimer, 2011). This concern to succeed at the critical stages related to a cognitive model of development of CR makes it possible to better evaluate its development. Thus, the reference to a cognitive learning model of the competency during the elaboration of educational strategies seems relevant (National Research Council, 2001; Tardif, 2006). In other words, if each educational strategy is not properly anchored to a cognitive learning model of CR, questions will always arise regarding the optimal assessment methods to use. In addition, a cognitive learning model of CR linked to the educational strategy could favor scaffolding and feedback adapted to the stages of competency development as well as progressive learning in nursing students.

Feedback: an essential interaction for scaffolding

In most of the studies that included students' appreciation, feedback was identified as essential to their learning and motivation. Several studies mentioned the importance of supervision and immediate feedback when teaching CR using an e-learning environment (Chan et al., 2016; Cobbett et al., 2016; Hoffman et al., 2011; Johnsen et al., 2016; Koivisto et al., 2016; LeFlore et al., 2012; Morey, 2012; Oldenburg and Hung, 2010; Sadhuwong et al., 2016). For example, Morey (2012)'s study reports the contribution of a web-based educational agent to foster the development of CR in students. The Socratic-type questioning used by the pedagogical agent suggests that this cognitive dialogue is necessary for learning; it mobilizes the semantic processing (putting into words) by the student. Thus, the articulation of knowledge remains a determining element to consider for the development of CR (Deschênes and Goudreau, 2017; Goudreau et al., 2014). The study by McCallum et al. (2011) reports further elements on this aspect. The authors consider that digital reflection and communication used in e-learning environments may be confounding variables that influence the decision-making process. The use of audio and video features is thus suggested to complement technological features. In this regard, several researchers have opted for discussion forums or chatrooms during and following the activity as well as programed and integrated interactions in the online strategy.

Modelling: the support needed for the student self-regulation and empowerment process

Few studies have explained the CR process of nursing education experts for student modelling (Park, 2013; Sadhuwong et al., 2016). For example, Sadhuwong et al. (2016) incorporated reflective role models from the early stages of the educational

strategy before students engaged in the decision-making process. The results showed that students were better at solving complex situations with less educational support, after the first demonstration of role models on the Web platform. In some studies, students have shown interest in understanding the interpretation of a good/bad answer and the consequences of it (Johnsen et al., 2016; LeFlore et al., 2012; Oldenburg and Hung, 2010). Learning needs seem to emerge and refer to an interpretative understanding of the response choices. In addition, capturing the nuances and subtleties of a teacher or patient in a real-life situation (Park, 2013) differs from standardized and algorithmically programed forms of response on a Web interface. The authenticity of practice situations as well as the modelling of the CR process thus remains challenging in designing educational strategies. In this sense, the complementarity of various educational strategies is necessary to reap the benefits of each of the teaching/learning situations.

Finally, figure 3 summarizes cues about principles of Web-based CC approach, scoped in this review, that could support the development of CR in nursing students. Exchanges between students and educators, discussion forums, feedback, trial-and-error procedures, iterations of learning, and gamification are all avenues currently explored to support the competency development. In addition, the contribution of a cognitive learning model must be considered to link learning to the developmental stages of CR and possibly to infer its development.

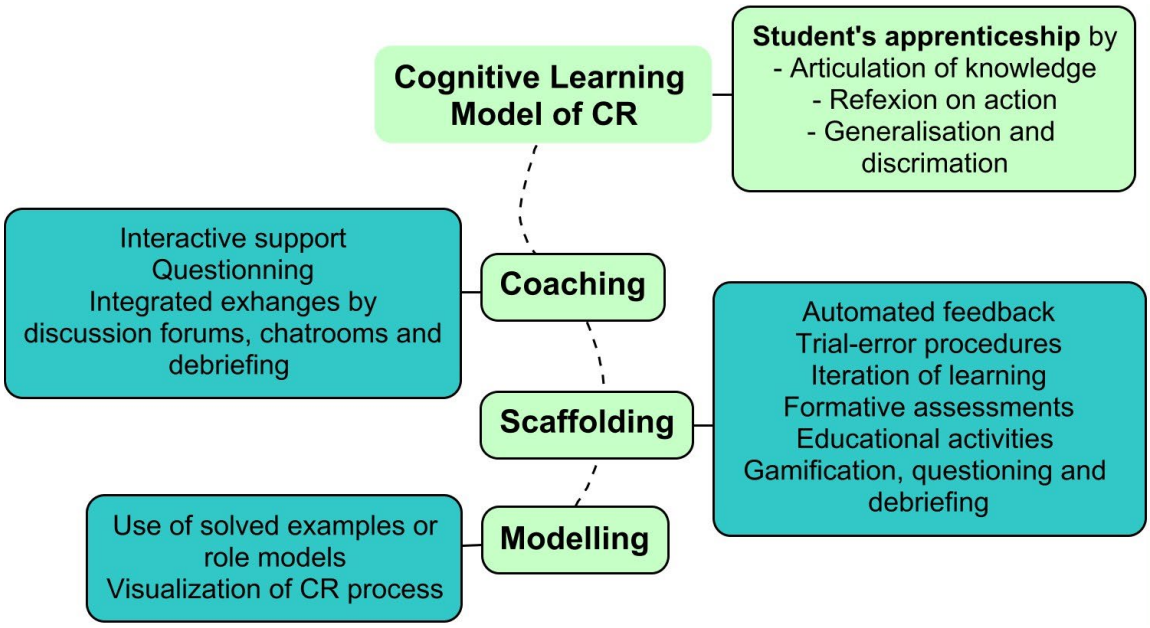

Figure 3: Web-based cognitive companionship approach for the development of nursing students' CR

Implications for research

Additional research should be conducted to measure the impact of educational strategies within e-learning environments for developing CR in nursing students. Explicit links between theoretical foundations and education strategies are also essential to ensure their transferability to other educational contexts (Thompson and Stapley, 2011). In this regard, the implementation of tools for learning and evaluating CR in nursing remains a challenge in programs. In a competency development approach, support and evaluation tools deserve particular attention to ensure consistency between the cognitive learning models of CR and the instrumentation used for the development and assessment of this competency (Tardif, 2006).

The educational strategies used in e-learning environments rarely externalize the cognitive and metacognitive processes of experts. Solved or worked examples (Chi et al., 1989; Sweller, 2006) could be useful for evaluating the effect of the externalization of the cognitive and metacognitive processes of experts on student learning. The principles underlying the use of the solved examples are based on the modelling of the student's CR processes by exposing and supporting those of the experts in resolving a care situation. Finally, in our scoping review, no studies explicitly showed the notion of fading in the CC approach. To our knowledge, the reported strategies used a predetermined sequence of learning activities. E-learning environments with standardized learning paths often fail to provide structured and individualized learning support for students. Thus, the contribution of new technologies must be considered to provide an individualized and directed paths based on the needs of each student (Fontaine et al., 2017).

Strengths and limitations of the scoping review

Strengths of this review include the use of a solid methodological framework that allowed the conduction of this project using a systematic approach (Joanna Briggs Institute, 2015). Moreover, the assistance of a librarian in the designing of the search strategy allowed us to specifically target the relevant literature. However, a first preselection, based on the reading of the title and summary, was conducted only by the principal author. In addition, only French and English studies were consulted. Moreover, our search strategy was limited to peer-reviewed journals indexed in the researched databases as it was judged that most of the relevant literature would be accessible through this method. Therefore, it cannot be excluded that relevant writing may have been left out. We tried to counteract this possibility by hand-searching the reference lists of included

studies and specific journals deemed relevant to the purpose of this review. Also, as this was a scoping review and as recommended in the methodological framework used (Joanna Briggs Institute, 2015), no quality evaluation of the writing was conducted. Therefore, direct implications for practice are hard to draw out of this project. The conducting of a systematic review of interventions could assist in characterizing the effectiveness of these e-learning environments.

Conclusion

Educational strategies in e-learning environments offer new and promising opportunities for developing CR in undergraduate nursing students. However, these strategies must be based on solid theoretical foundations to provide support for the development of this competency.

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