Virtual Patients in Nursing Education: Teaching, Learning and Assessing Clinical Reasoning Skills

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To all past, present, and future generations of nursing students and nurse educators who appreciate the complexity, creativity and challenges involved with teaching, learning and assessing clinical reasoning.

If there is no struggle, there is no progress

Frederick Douglass

ABSTRACT

Background: One challenge in nursing education is to teach nursing students to apply their knowledge when dealing with clinical problems. Nurses who possess effective clinical reasoning skills have more positive patient outcomes compared to nurses with poor clinical reasoning skills. Clinical reasoning is therefore a competence nursing students must acquire during nursing education. However, the teaching, learning and assessment of clinical reasoning present challenges for both learners and teachers, and more knowledge is needed about different methods to support the training and assessment of clinical reasoning for nursing students. Virtual patients are increasingly being used in nursing education as a way to teach, learn and assess nursing students' clinical reasoning competence.

Aim: This thesis aims to increase knowledge about how to design virtual patients for the use of teaching and learning clinical reasoning for nursing students and how to assess different aspects of nursing students' competence regarding clinical reasoning in encounters with virtual patients.

Method: Study I investigated which aspects of clinical reasoning should be present in a virtual patient model and how that model should be presented as a learning activity. The Outcome – Present State – Test (OPT) model was chosen as a theoretical foundation for the development of a virtual patient model. A multidisciplinary team used an iterative approach to design the virtual patient model and virtual patient cases based on the OPT model. Study II investigated nursing students' experiences of using virtual patients based on the model developed in study I. A quantitative-qualitative content analysis utilising the text analysis program Gavagai Explorer was performed. The focus of study III was to develop an assessment rubric aimed at assessing nursing students' clinical reasoning skills in encounters with virtual patients. The Lasater Clinical Judgement Rubric (LCJR), based on the conceptual framework of Tanner's clinical judgment model, was chosen to serve as a model for developing a new rubric. The method for developing the new rubric was a combination of qualitative deductive content analysis and abductive analysis. The focus of study IV was to determine the psychometric properties of the virtual patient version of the rubric developed in study III. The psychometrics of the rubric were examined using exploratory factor analysis.

Findings: In study I, the virtual patient Design Nursing Model (vpDNM) which aimed to provide a structure for teachers when authoring virtual patients intended for nursing education was developed. Study II identified seven topics reflecting students' experiences of using virtual patients in the context of learning activities, and four topics relating to the context of assessment were identified. Overall,

students seemed to value virtual patients' ability to visualise clinical reasoning. In study III, a rubric called the virtual patient version of LCJR (vpLCJR), which aimed to assess nursing students' clinical reasoning competences in encounters with virtual patients was developed. Study III, showed that the vpLCJR can be used for a structured assessment of nursing students' clinical reasoning in encounters with virtual patients. The results show that the rubric has the ability to capture both levels and progress of students' clinical reasoning.

Conclusions: A conclusion based on the results of studies I and II presented in this thesis is that virtual patients based on the virtual patient design model are well suited for teaching, learning and assessing nursing students' clinical reasoning skills. Using theory-anchored virtual patients adapted for nursing education could support students in their development of clinical reasoning by making thinking strategies and tactics used in reflective clinical reasoning more explicit. Virtual patients can also be used for teaching and learning in connection with the documentation of patient care and the accurate use of standardised terminologies in patient records. Furthermore, the results also propose that a virtual patient based on the virtual patient Design Nursing Model is well suited to be used in formative and summative assessment, as well as for students' self-assessment. A conclusion based on the results of studies III and IV is that the developed rubric can be used to assess different aspects as well as the levels and progress of nursing students' clinical reasoning. Furthermore, the vpLCJR provides both students and educators with a defined set of performance criteria. The results also suggest that the vpLCJR is a valid and reliable assessment instrument for nursing students' clinical reasoning in encounters with semi-linear virtual patients.

LIST OF SCIENTIFIC PAPERS

This thesis is based on four papers, that will be referred to by their Roman numerals I, II, III and IV in the text.

I.   **Georg, C**., Zary, N. (2014). Web-Based Virtual Patients in Nursing Education: Development and Validation of Theory-Anchored Desing and Activity Models. *Journal of Medical Internet Research Vol. 16(4)*

II. **Georg, C**., Welin, E., Jirwe, M., Ulfvarson, J., Broberger, E., Karlgren. K. Understanding nursing students' experiences of virtual patients in the context of learning activities and high-stake summative assessments. (*Manuscript*)

III. **Georg, C**., Karlgren, K., Ulfvarson, J., Jirwe, M., Welin, E.(2018). A Rubric to Assess Students Clinical Reasoning When Encountering Virtual Patients. *Journal of Nursing Education Vol. 57 (7), pp. 408–415*

IV. **Georg, C**., Welin, E. Jirwe, M., Karlgren, K., Ulfvarson, J. Psychometric properties of the virtual patient version of the Lasater clinical judgement rubric *(Submitted)*

DEFINITION OF TERMS AND LIST OF ABBREVIATIONS

For the purpose of this thesis, the following terms are defined:

Clinical reasoning   A logical process by which nurses collect cues, process information, come to an understanding of a patient situation, plan and implement interventions, evaluate outcomes, and reflect on and learn from this process.

Virtual patient   Interactive computer simulations of real life clinical scenarios for the purpose of medical training, or assessment.

Rubric   A measurement instrument for assessing students' performance on the basis of behavioural descriptions in relation to intended learning outcomes.

LIST OF ABBREVIATIONS

LCJR   Lasater Clinical Judgment Rubric
OPT   Outcome – Present State – Test model
VP   Virtual patient
vpLCJR   Virtual patient version of the Lasater Clinical Judgment Rubric
vpNAM   Virtual patient nursing activity model
vpNDM   Virtual patient nursing design model

CONTENTS

1   INTRODUCTION

Worldwide nursing practice in the 21st century faces a wide range of challenges that have an impact on patient safety. These challenges are due to profound changes in science, advances in technology, increasing population, an increase in the number of frail and older patients, escalating health costs and a shortage of nurses (NACNEP, 2010). These challenges and changes in nursing practice have an enormous implication for nursing education (Benner, 2012; Benner, Tanner, & Chesla, 2009). New nurses need to be prepared to practise accurate, safe and compassionate care in different contexts where knowledge is expanding rapidly. Nursing students must also learn to be inventive and creative to meet the future demands of healthcare (Benner, Sutphen, Leonard, & Day, 2010; NACNEP, 2010).

An important prerequisite for nursing students to pursue a safe care is to acquire theoretical scientific knowledge and deliberately convert this theoretical knowledge into patient-related practice. In other words, the students must be able to integrate theory and practice. Studies show, however, that nursing students find it difficult to translate and apply their theoretical knowledge in clinical situations, and that nursing students and new graduate nurses struggle with clinical reasoning (Lee, Lee, Bae, & Seo, 2016; Theisen & Sandau, 2013). This is a problem that has an impact on patient safety. Hence, nurses who show effective clinical reasoning competence have positive patient outcomes in comparison to nurses with poor clinical reasoning competence, who may fail to detect a deteriorating patient, resulting in a "failure to rescue" (Aiken, Clarke, Cheung, Sloane, & Silber, 2003). Clinical reasoning is therefore a skill that every nurse needs (Banning, 2008; Benner et al., 2010; Cappelletti, Engel, & Prentice, 2014). However, teaching and learning clinical reasoning present challenges for both teachers and learners (Delany & Golding, 2014; Pinnock & Welch, 2014). In order to prepare nursing students for the demands of today's and tomorrow's healthcare workplace, educators must focus on the development of critical thinking and reasoning, and there is a need for more knowledge of different methods to support the learning and assessment of nursing students' clinical reasoning.

The National League for Nursing Research Priorities in Nursing Education 2016–2019 calls for the discovery and translation of innovative evidence based strategies such as examination and the use of technology, simulation, informatics, and virtual experiences in student learning that affects clinical practice (National League for Nursing, 2016). In this thesis, entitled *"Virtual patients in nursing education: teaching, learning and assessing clinical reasoning skills",* the potential for supporting students to develop clinical reasoning using virtual patients is studied.

1

1.1 Overview and outline of the thesis

The purpose of this thesis was to increase knowledge about how to design virtual patients for the use of teaching and learning clinical reasoning for nursing students and how to assess different aspects of nursing students' competence regarding clinical reasoning in encounters with virtual patients.

The research was conducted in the context of nursing education, and examined the domain of clinical reasoning from two perspectives; as a learning activity and for assessment. The tool used to train and assess clinical reasoning was virtual patients. The theoretical underpinning for studies I and II was the Outcome-Present State-Test model (OPT) model (Pesut & Herman, 1998, 1999) and the theoretical underpinning, studies III and IV was based on Tanner's clinical judgment model (Tanner, 2006). An overview of the content of this thesis and the specific research questions are presented in Figure 1.
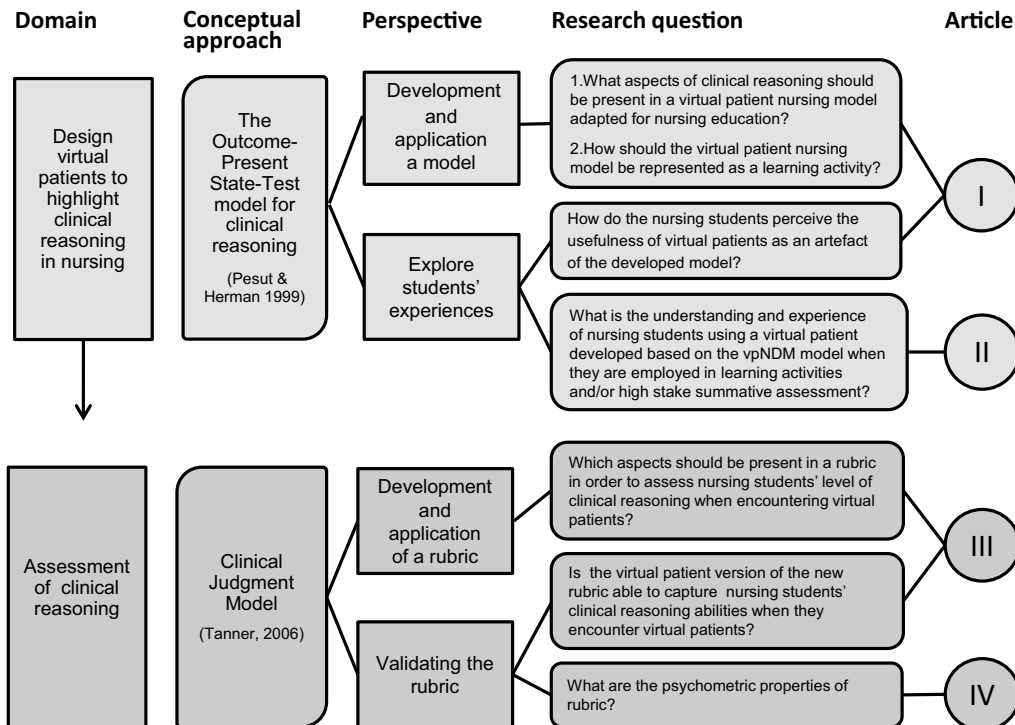

Figure 1. *Overview of the thesis.*

2 BACKGROUND

This background seeks to describe the main concept of this thesis, articulate patterns within scholarly literature and presents the rationale of the thesis.

Based on the aim of the thesis, the background broadly describes and defines aspects and issues that show how this thesis fits into the larger scientific discourse. This chapter then seeks to provide an overview of existing empirical research and scholarly work related to the terms *clinical reasoning* and *virtual patients*. Virtual patients are the educational tool used in this research project, placed in the context of nursing education in relation to training and assessing clinical reasoning.

2.1 Nursing education

From a global perspective the content, organisation and quality of nursing education differs in many countries (Morin, 2011; World Health organization, 2009)**.** The nursing education programme in Sweden is a three-year post-secondary education leading to a Degree of Bachelor of Science in Nursing and a licence to practise as a registered nurse (RN). To meet the national requirements for nursing education, the nursing curriculum consists of theoretical courses in nursing science, medical science and social and behavioural science as well as clinical courses (Råholm, Hedegaard, Löfmark, & Slettebø, 2010). Approximately half of the time is dedicated to clinical education that takes place in various in- and outpatient hospital healthcare settings. Learning in healthcare education is complex and student nurses at bachelor's level have to learn to manage practical skills as well as developing professional and academic competences (Benner et al., 2010; Jeppesen, Christiansen, & Frederiksen, 2017). The national requirements for achieving a nursing degree are stated by the Swedish Higher Education Ordinance. These requirements are stated as educational goals within the learning domains of knowledge and understanding, skills and abilities, and appraisal ability and attitudes (SFS 1993:100).

In this thesis I will use the term "nursing education" when talking explicitly about nursing education. "Medical education" is the term I will use to refer to various types pf educations for healthcare professionals including nursing.

2.2 Theoretical perspectives on teaching, learning and assessment

This thesis does not set out to investigate teaching, learning and assessment per se. The focus is more on increasing knowledge about how teaching, learning and assessment with virtual patients in order to develop nursing students' clinical reasoning competence can be improved. Using educational theories to inform

the design of technology-induced learning activities are an important but often neglected first step in order to facilitate effective teaching and learning (Sandars, Patel, Goh, Kokataaio, & Lafferty, 2015). Therefore in this thesis, theories that are relevant for learning and assessing clinical reasoning in nursing (see 2.4.1) are used when designing the virtual patients and adapting the assessment instrument. Theoretical perspectives on teaching, learning and assessment can also be useful for comparing and juxtaposing the significance of the findings in this thesis with other contexts and a more general level. Various theories about teaching, learning and assessment have their own identities, but they also have some commonalties and together they provide some important and unique perspectives relevant to understanding learning with virtual patients.

2.2.1 Teaching

The concept of teaching is a complex process intent to facilitate learning (Gaberson & Oermann, 2010). Teaching is often confused with schooling (Smith, 2015). The goal of teaching is to lead students to discover knowledge themselves. The teachers role is to encourage the students to discover knowledge promote self-mastery, autonomy and self-esteem through deliberate teaching action (Benner et al., 2009; Gaberson & Oermann, 2010) and provide structure and learning activities (Gaberson & Oermann, 2010). In this thesis education is defined as a "*wise, hopeful and respectful cultivation of learning undertaken in the belief that all should have the chance to share in life*"(Smith, 2015). According to this educators look to act with people rather than on them, and their task is to "*educe*" (related to the Greek *educate*), to bring out or develop potential. Such education is deliberate and hopeful, informed, respectful and wise, as well as being grounded in a desire that at all may flourish and share in life (Smith, 2015).

Another assumption in this thesis is the ideas underlying constructive alignment when designing learning activities. Learning activities are defined as activities developed by the teacher and aiming to create the right conditions for learning, and that constructive alignment has an out-come based approach. It is the design of teaching where the intended learning outcomes is clearly stated before the teaching and learning takes place, and where the teaching is designed to engage students in activities that optimise their chances of achieving these outcomes (Biggs, 2014).

2.2.2 Learning

The concept of learning is also complex, and can be described and understood from different perspectives. Understanding the phenomenon of "learning" means not only understanding the learning process, but also understanding the conditions that influence and are influenced by the learning process (Illeris, 2009). In the present

thesis, learning during simulation in a virtual patient encounter, which can be seen as having inherent characteristics and a particular type of complexity is studied.

The rapid development of technology has resulted in technology now being an established part of the landscape for many aspects of daily life including education. With this development comes the potential and opportunities to influence different aspects of students' learning. Experience and technological advancements have the potential to provide opportunities to enhance and develop a more personalised student centred style of learning (King et al., 2018).

2.2.3   Assessment

Assessment is a fundamental part of the educative process. Nevertheless, this concept has been described from different perspective, ranging from assessment as an evaluative/ feedback action in education to a certification procedure leading to a pass or fail decision (Schuwirth & van der Vleuten, 2010). In this thesis assessment is seen as any deliberate and formal action to obtain information about the learning progress and competence of a student.

Formative and summative assessment are two different aspects on evaluate students learning. Formative assessment, is assessment for learning, and is used to monitor students' learning while providing feedback to learners about their learning and progress. It is used to improve learning and to develop students' self-regulated learning processes. Summative assessment on the other hand, is an assessment of learning, and is used to evaluate students' learning or their achievement of the intended learning outcomes at the end of a course or a programme. It is used to compare students' achievements against specific standards or benchmarks (López-Pastor & Sicilia-Camacho, 2015; Wodd, 2010). In this thesis, the assumption is that it is important to describe the intended learning outcome for the assessment and that the assessment task contains that verb that enables the learners (and the teacher) to define how well learners' performances meet the criteria for the assessment.

Assessment of clinical reasoning competence is challenging. Scoring rubrics are suggested to help teachers and learners to change the traditional and often subjective assessment into a more objective evaluation, and to enhance the communication of different aspects and levels of clinical reasoning (Fleiszer, Hoover, Posel, Razek, & Bergman, 2017; Shipman, Roa, Hooten, & Wang, 2012; Vreugdenhil & Spek, 2018). A rubric is a measurement instrument for assessing students' performance on the basis of behavioural descriptions in relation to intended learning outcomes (Davis & Kimble, 2011).

2.3   Professional Competence

Professional competence is a complex concept and there is no agreed definition of competence that covers all important domains of professional practice. Epstein & Hundert, (2014) propose that professional competence is *the habitual and judicious use of communication, knowledge, clinical reasoning, emotions, values and reflection in daily practice for the benefit of the individual and community being served.* Four functions are described as being included in professional competence: cognitive function, integrative function, relational function and affective/moral function (ibid.). In this thesis, the assumption is that clinical reasoning is one important professional competence and that every nursing student needs to develop clinical reasoning competence during nursing education.

2.4   Clinical reasoning

Clinical reasoning is also a difficult concept to define and for students to grasp, although the concept is fundamental to all forms of professional health practice (Norman, 2005) and is regarded as a core competency in medical education (Posel, Mcgee, & Fleiszer, 2015). In general, the term "clinical reasoning" describes the problem-solving approach taken by clinicians while making decisions about the diagnosis and management plan for a patient. It involves the application of knowledge in order to collect and integrate information from various sources (Higgs & Jones, 2008). One often used definition of the term "clinical reasoning" in medical education is that clinical reasoning is the ability to *"sort through a cluster of features presented by a patient and accurately assign a diagnostic label, with the development of an appropriate treatment strategy as the end goal"* (Eva, 2005). The availability of necessary domain knowledge, the association of this knowledge with evidence-based research and its subsequent application through decision making, clinical judgment and active problem-solving seem to be essential elements of clinical reasoning (Higgs & Jones, 2008).

In nursing, clinical reasoning represents the framework of nursing practice and is essential for preserving the standards of the nursing profession and promoting good patient outcomes (Cappelletti, Engel, & Prentice, 2014; Fonteyn & Ritter, 2008). Clinical reasoning skills are an expected component of expert and competent practice (Banning, 2008). The term "clinical reasoning" is however a difficult concept to define, and the term is applied to diverse approaches. There is no consensus or common understanding of what clinical reasoning in nursing implies, and the terms "clinical reasoning", "clinical decision-making", "critical thinking" and "problem-solving" tend to be used interchangeably (Banning, 2008; Benner et al., 2010; Tanner, 2006). Clinical reasoning in nursing can be referred to as the cognitive processes nurses use when reviewing and analysing patient data in order

to understand the patient's situation, make decisions on the patient outcome and plan the care (Fonteyn & Ritter, 2008). Effective clinical reasoning skills enable students to collect data, solve problems, make decisions, provide quality care and survive in the workplace. Effective and efficient clinical reasoning requires knowledge, skills and abilities grounded in theory and supported by evidence. Reflection, supported by an individual's capacity for self-regulation leads to the development of expertise (Benner, 1982; Cleland, Walker, Gale, & Nicol, 2016; Kuiper, O´Donnel, Pesut, & Turrise, 2017; Pesut & Herman, 1998, 1999).

In this thesis, the term "clinical reasoning" in nursing is used to define a logical process by which nurses collect cues, process information, come to an understanding of a patient's situation, plan and implement interventions, evaluate outcomes, and reflect on and learn from this process.

2.4.1   Theory of clinical reasoning

Early attempts to formulate a universal algorithm for clinical reasoning have failed due to the content specificity of the clinical reasoning process (Norman, 2005). Research and discussion surrounding clinical reasoning have shifted focus from attempting to understand clinical reasoning as a general skill, to understanding clinical reasoning as probes of memory, and ultimately understanding clinical reasoning from different kinds of mental representation (Norman, 2005). Below are three clinical reasoning theories (the dual process theory, the OPT Model and Tanner's clinical judgment model "Thinking like a nurse") that can be useful in order to understand clinical reasoning in nursing in relation to the virtual patients discussed.

2.4.1.1   Dual process theory

Today, the dual process theory of clinical reasoning is often discussed in relation to clinical reasoning. The dual process can be broken down into two separate but interconnected processes that have been characterised as non-analytical (system 1) and analytical (system 2) reasoning (Audétat, Laurin, Dory, Charlin, & Nendaz, 2017; Croskerry, 2009; Norman et al., 2014; Schubach, Goos, Fabry, Vach, & Boeker, 2017) . The "non-analytical" (system 1) reasoning is a rapid, unconscious, intuitive process primarily driven by pattern recognition based upon prior experience. The analytical (system 2) reasoning is a slower, systematic, conscious process driven by logic and the application of explicit rules (Croskerry, 2009; Norman et al., 2014; Schubach et al., 2017). When experienced clinicians deal with a routine case, they have a tendency to make extensive use of non-analytical, subconscious reasoning strategies (system 1) that essentially depend on matching newly encountered patient cases to previously seen patient cases, and only gather a reduced set of clinical information in order to establish a conclusion. By contrast, students and novice

professionals or experts in non-routine cases use deliberate analytical (System 2) reasoning patterns (Schubach et al., 2017). This may explain why experienced healthcare instructors or teachers often find it difficult to slow down and fully explain their clinical reasoning to learners (Croskerry, 2009; Pinnock & Welch, 2014; Schubach et al., 2017). In this thesis the dual process theory, partly explains how virtual patients' can foster learners' development of clinical reasoning.

2.4.1.2 The OPT model

The outcome-Present State-Test (OPT) model is a model that supports teaching and learning of clinical reasoning in nursing. The OPT model serves as both a method for self-regulation in nursing and a patient-centred clinical reasoning model (Kautz, Kuiper, Pesut, Knight-Brown, & Daneker, 2005; Kuiper et al., 2017; Pesut & Herman, 1998). The OPT model is based on the traditional nursing process, but also differs from the traditional nursing process in several ways.

The traditional nursing process has provided a structure for clinical thinking in nursing since the 1950s. This traditional nursing process was designed to organise thinking to anticipate and solve problems encountered by patients. Over time, the nursing process has developed and three generations of nursing processes can now be identified. The first generation nursing process (1950–1970) focused on problems and processes, and structured clinical thinking through a four-step problem-solving model of *assessment, planning, intervention and evaluation.* Much of the nursing process was organised around body systems and pathophysiological issues. Over time, nurses began to differentiate between the nursing care perspective and the medical perspective, and realised that they needed to develop and define terms and language to describe the scope and focus of nursing practice. A problem solution pattern emerged. Nurses started to pay attention to patterns and relationships between and among signs, symptoms and behaviour cues, as well as defining characteristics associated with patients' responses to their illness and health condition. Nursing diagnoses standardised terminologies that represent, explain, define and labels patterns of behaviour exhibited by patients within the domain of nursing practice were developed. The four-step model of assessment, planning, intervention and evaluation was changed and evolved to a five-step model of assess, *diagnose*, plan, intervene and evaluate.

The second generation of nursing process (1970–1990) focused on diagnosis and reasoning, and explaining the nature of diagnostic reasoning with a nursing mindset. The work to support the creation of standardise terminologies continues. The advantages and disadvantages of the nursing process were debated (Kuiper et al., 2017; Pesut & Herman, 1998, 1999). Scholars began to explore how nurses think about their practice (Benner, 1982; Tanner, 2006), and the nature of clinical reasoning and thinking in nursing became a focus for nursing education research.

Rules regulations and policies in the healthcare sector shifted from focusing on problems to a focusing on the identification of desired outcomes (end results). The nursing process changed and outcome specifications that didn't receive explicit attention in the first two generations was incorporated into the third generation nursing process.

The OPT model is a third generation nursing process (1990- ongoing) with an emphasis on outcome specification given a presented problem state that emanates from an evaluation and analysis of the competing needs the patient may experience. The OPT model emphasises reflection, outcome specification, testing and the development of clinical reasoning and judgment given the context of a patient's story. The OPT model suggests strategies to help nurses gain insights into the juxtaposition between the identified present state and the desired outcome state (Kuiper et al., 2017; Pesut & Herman, 1999). Today, current standards and descriptions of the nursing process offered by the (American Nurses Association, 2015) provide a six step nursing process: assessment, diagnosis, *outcome identification,* planning, implementation and evaluation.

In this thesis, the OPT model is the theoretical foundation on which to designing virtual patients and the associated learning activities.

2.4.1.3   Tanner's "Thinking like a nurse"

Another evidence-based model of clinical reasoning and judgment used in nursing education worldwide is Tanner's (2006) Clinical Judgment Model, "Thinking Like a Nurse". This model describes the process used by nurses to best respond to clinical situations. This model describes the clinical reasoning of experienced nurses, but can also serve as guidance for a teacher to support students in focusing attention on clinical reasoning. The model is a synthesis of the 191 research studies in the field of clinical reasoning /judgment in nursing. Tanner focuses not only on the cognitive and metacognitive processes of thinking and reasoning, but also on the psychomotor processes of actions and the affective processes the caregiver takes into account (not only the knowledge and application to a specific patient but also the affective aspects of the caregiver and the environment). The process is thereby influenced by context and complexity for two major sources: the patient and the nurse.

The model is based on four aspects; Noticing, Interpreting, Responding and Reflecting (Figure 2). *Noticing* is about a perceptual grasp of the situation at hand. It is a function of the nurse's expectation of the situation and not necessarily the outcome of assessment. The expectation derives from the nurse's knowledge from "knowing the patient", knowing the patient's patterns of responses, clinical knowledge drawn from experience and textbook knowledge. *Interpreting* is about developing a sufficient understanding of the situation, and *responding* is about deciding

on a course of action that is appropriate for the situation. The final dimension of the process is *reflection (ibid) which* can be seen as reflection *in* and *on* action (Schön, 1983). Reflection in action refers to the nurse's ability to read the patient and adjust to the situation. Refection on action refers to the nurse's clinical learning from the situation (Tanner, 2006).
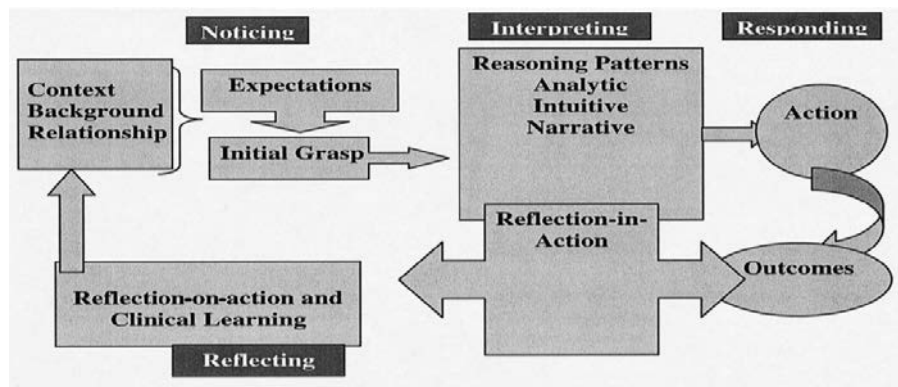

Figure 2. Tanners clinical judgement model. Thinking Like a Nurse; Tanner, C. (2006). Thinking like a nurse: A research-based model of clinical judgment in nursing. Journal of Nursing Education, 45(6), 204-211.

In this thesis, we used Tanner's model to deconstruct different aspects of clinical reasoning when designing a rubric that aims to assess nursing students' clinical reasoning competence in the context of virtual patient simulation.

2.4.2 Teaching, learning and assessing clinical reasoning

Clinical reasoning is a complex competence students have to acquire during their education. Since clinical reasoning plays such a major role in patient outcome and patient safety, the development of nursing students' clinical reasoning competence is a major goal of nursing education (Jessee & Tanner, 2016). Although clinical reasoning is a fundamental competence and the concept has been a focus of research for over 50 years, is it not yet fully understood (Wang, 2011). Uncertainty remains in connection with how to translate what we know about how health care professionals reason in order to understand the situation into instructional approaches to teach clinical reasoning (Eva, 2005; Linsen, Elshout, Pols, Zwaan, & Mamede, 2018). Students often find it difficult to grasp clinical reasoning and educators often find it difficult to fully explain their clinical reasoning processes. This is due to the fact that the clinical reasoning process includes dynamic nonlinear and unconscious components (Hege, Kononowicz, Berman, Lenzer, & Kiesewetter,

2018; Norman, 2005). Previous studies point out that there is not one strategy, alone or in combination that is considered to be the most effective in developing clinical reasoning and judgment skills (Cappelletti et al., 2014). The emphasis on teaching students to become competent professionals nurses with skills in clinical reasoning has shifted during the last few decades from mostly delivering facts to a more complex problem-solving approach (Brown Tyo & McCurry, 2018; Norman, 2005). During medical education, clinical reasoning is often taught in clinical courses by seeing many patients, actively engaging in problem solving, receiving sufficient feedback and problem-based tutorials with varied and multiple examples of clinical cases (Norman, 2005; Eva, 2005). The learning of clinical reasoning takes time, patience, education, experience and reflection (Koharchik, Caputi, Robb, & Culleiton, 2015). While learning clinical reasoning, students can benefit from an evidence based practical model that demystifies and advance's clinical reasoning skills (Kautz et al., 2005). A valid and reliable assessment of clinical reasoning requires a sufficient sampling of cases across different domains (Schubach et al., 2017). Nowadays, virtual patients are becoming an increasingly important learning activity to train and assess clinical reasoning and to prepare learners for real patient encounters (Cook & Triola, 2009; Hege et al., 2018; Schubach et al., 2017).

2.5   Virtual patients

The term "virtual patient" has been used for many years in various contexts, such as clinical research, electronic patient records and in medical education (Kononowicz, Zary, Edelbring, Corral, & Hege, 2015). This thesis focuses on virtual patients used in the context of nursing education. Virtual patients in medical education are defined as patient case simulations presented on a computer screen. One definition is that virtual patients are *"interactive computer simulations of real-life clinical scenarios for the purpose of medical training, education, or assessment"* (Ellaway, Poulton, Fors, McGee, & Albright, 2008). Another definition defines virtual patients as *"a specific type of computer-based program that simulates real-life clinical scenarios; learners emulate the roles of health care providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions"* (AAMC, 2007). One central aspect of virtual patients includes interactivity on the learner's part (Cendan & Lok, 2012). The learner takes on the role of a health-care professional and has to interact with the virtual patient in order to understand the patient story, and make diagnoses and therapeutic decisions based on the presented content in the case (Cook & Triola, 2009). Another characteristic is that the story of the patient is central and that the simulation presents a variation of signs and symptoms, modelling a medical condition or a healthcare problem (Posel, Mcgee, & Fleiszer, 2015). A typical virtual patient simulation session includes a stepwise unfolding of the scenario, by interviewing and assessing the patient, requesting different tests, diagnosing and treating, and thereafter receiving feedback on the action taken (Huwendiek, 2016).

2.5.1 Evolution of virtual patients

Different types of computer aided simulation of clinical encounters allowing health care students to interact actively with a patient have been around for over 50 years. The first description that can be defined as a virtual patient application was published in 1966, and describes a system aiming to train nursing students in the care of patients with myocardial infarction and angina pectoris (Blitzer, 1966). This was soon followed by other examples for health care education. At that time, virtual patients were described as "*the computer assumes the role of a patient and the student that of a practicing physician*"(Harless, Drennond, Marxer, Root, & Miller, 1971). Karolinska Institutet implemented virtual patients in education and started to conduct research in the field of virtual patients in the early nineties (Bergin & Fors, 2003). In the nursing programme at Karolinska Institutet, the first virtual patient case was pilot tested as an educational activity in 2006. Virtual patient cases are now implemented in the syllabus for both the undergraduate study programme in nursing and the specialist nursing programme.

Since the first study was published, virtual patients have been described as a tool used for various aspects of training for the education of different health care professions such as medicine, pharmacy, dentistry and nursing. Despite the fact that the concept has been around for 50 years, few medical schools have incorporated it into their educational curriculums. In 2005, only 24% of medical schools in Canada and the USA were using virtual patients. One reason for the low rate of adoption may relate to the cost of developing virtual patient scenarios (Huang, Reynolds, & Candler, 2007). However, virtual patients have become increasingly easy to develop and the production cost is therefore constantly falling. This is currently a growing area of interest, and virtual patients are recognised as a valuable teaching tool in medical education (Hege, Kononowicz, Tolks, Edelbring, & Kuehlmeyer, 2016) including nursing (Foronda et al., 2017; Kleinert et al., 2015). The exact adoption rate worldwide is however difficult to estimate.

2.5.2 Virtual patients in nursing education

Since the first study using virtual patients in nursing education was published in the mid-sixties, virtual patients have been described for training and assessment in various aspects of nursing education. Virtual patient simulations have found their way into various nursing schools, and are seen as an additional learning strategy to improve the learning of different skills (Donovan et al., 2018; Dubovi, 2018; Foronda et al., 2017). In recent years, several studies have been published using virtual patients and addressing their use for different learning objectives in nursing education. Virtual patients have been used to train non-technical skills (Peddle, Bearman, & Nestel, 2016; Peddle, Mckenna, Bearman, & Nestel, 2018). Guise, Chambers & Valimäki (2012) and Sunnqvist, Karlsson, Lindell, & Fors (2016)

used virtual patients to train skills such as critical thinking, communication and decision making in a mental health context. LeFlore et al. (2012) used virtual patients to teach nursing students about paediatric respiratory content. Some studies address physical assessment skills (Kelley, 2015) and the prescription of pharmaceutical drugs (Hurst & Marks-Maran, 2011). Virtual patients have also been used as a substitute for clinical hours (Jimenez, 2017) and the assessment of nursing students' clinical reasoning skills (Forsberg, Georg, Ziegert, & Fors, 2011; Forsberg, Ziegert, Hult, & Fors, 2016).

2.5.3   The motivation for using virtual patients

The use of virtual patients can be motivated from different perspectives (Berman, Durning, Fischer, Huwendiek, & Triola, 2016). A virtual patient has the potential to bridge the gap between theoretical knowledge and clinical practice, and can therefore be motivated by the need for an intermediate step between basic science and the practice of clinical subjects (Edelbring, Dastmalchi, Hult, Lundberg, & Dahlgren, 2011). Clinical learning experiences are difficult to standardise. Virtual patients have the benefit of repeatedly providing the same experience, and have the potential to provide learners with opportunities to revisit the action taken during the interaction with the "patient", allowing for comparison with best practice protocol (Cendan & Lok, 2012). The interactivity in virtual patients has the potential to supply experiential learning by motivating the learner to participate actively in the educational process (Cendan & Lok, 2012; Edelbring et al., 2011; Salminen, Zary, Björklund, Toth-Pal, & Leanderson, 2014). Virtual patients are also believed to foster active learning (Consorti, Mancuso, Nocioni, & Piccolo, 2012) and can provide opportunities for self-directed learning, leading to reflection and self-driven change as well as self-knowing regarding performance (Cendan & Lok, 2012). Another advantage is that virtual patients can add to learners' general knowledge by presenting clinical variations which the learners can employ when confronted with similar cases (Cook, Erwin, & Triola, 2010; Foronda et al., 2017).

The use of virtual patients also provides students with nearly unlimited opportunities to practise skills in a safe, standardised and realistic environment, and to receive immediate feedback on their actions (Berman et al., 2016). The use of virtual patients is also a way for students to overcome limited access to real patients (Poulton & Balasubramaniam, 2011). When working with virtual patients, the learners are offered a simulated clinical experience, providing mechanisms for information gathering and clinical decision-making in a "safe zone", without the risk of harming real patients (Ellaway, Poulton, Smothers, & Greene, 2009). Virtual patients can thereby provide an opportunities to facilitate a venue for safe and repetitive practice, and act as a model where progressive clinical variation and difficulty can be presented (Cendan & Lok, 2012). In line with this, virtual

patients have the potential to decrease the number and effects of medical errors (Geha, Trowbridge, Dhaliwal, & Olson, 2018). As with other types of e-learning technologies, an inherent advantage is the flexible learning time and place (Cook et al., 2010).

2.5.4   Virtual patients and clinical reasoning

Virtual patients have been acknowledged to be well suited to support teaching, learning and assessment of students clinical reasoning (Berman et al., 2016; Cook & Triola, 2009; Fleiszer, etal., 2017; Huwendiek, Reichert, et al., 2009; Posel et al., 2015). One hypothesis is that virtual patients support the acquisition of non-analytical (system1) clinical reasoning skills by teaching pattern recognition mechanisms, by exposing the learner to a large number of patient cases (Cook and Triola, 2009). Research has shown that students develop clinical reasoning skills by seeing many patients, while at the same time actively engaging in the patient's problem by trying to solve the problem and receiving sufficient feedback (Norman, 2005). It is argued that a virtual patient could also support the training of analytical (system 2) reasoning. Recently, Posel et.al. (2015) published a list of twelve tips on how to support the development of clinical reasoning skills using virtual patient cases, supporting both system 1 and system 2 reasoning. However, there is currently a need for more research on if and how virtual patients can support system 2 reasoning.

One problem when using virtual patients to train clinical reasoning skills is that there is a lack of a validated evaluation instrument for different virtual patients' capacity to enhance clinical reasoning skills (Hege et. al., 2018). Huwendiek et al., (2015) published a framework for an instrument that appears to have reasonable validity evidence of medical student's perception of virtual patient design with a special focus on clinical reasoning. However, there are no instruments to assess the clinical reasoning process for nursing students as they encounter virtual patients.

2.6   Rationale for the thesis

Nurses who show effective clinical reasoning skills have positive patient outcomes in comparison to nurses with poor clinical reasoning skills, and clinical reasoning is therefore a skill that every nurse needs. However, the teaching and learning of clinical reasoning presents challenges for both learners and teachers, and more knowledge of different methods is needed to support the training and assessment of clinical reasoning for nursing students.

The studies discussed above indicate that virtual patients are well suited to foster clinical reasoning for students in medical education. Although a number of studies attest to the effectiveness of virtual patients in fostering and assessing medical students' development of clinical reasoning, the results are inconclusive. Introducing virtual patients could improve nursing education, but scientific studies are needed to find out whether their role is adequate. There is still a lack of research on how virtual patients could support nursing students' training in clinical reasoning. It is therefore of interest to investigate the role of virtual patient simulation in nursing education. There is also a lack of evidence-based knowledge about how the learning of nursing scientific knowledge and clinical reasoning in nursing occurs in encounters with virtual patients. In particular, questions remain about how to present virtual patients' with a focus on nurses' clinical reasoning and how to assess nursing students' clinical reasoning in encounters with virtual patients.

3   AIM

The overall aim of this thesis was to increase knowledge about how to design virtual patients for the use of teaching, and learning clinical reasoning for nursing students, and how to assess different aspects of nursing students' competence regarding clinical reasoning in encounters with virtual patients.

3.1   Specific study aims

This thesis consists of four studies with the following aims:

I   A) To develop a theory-anchored model for developing virtual patients in nursing education, B) to investigate how virtual patients could be instantiated as a learning activity and finally, C) to explore students' perceived usefulness of virtual patients based on the developed model.

II   To examine nursing students' experiences of virtual patients in the context of learning activities as well as in high-stake summative assessments.

III   A) To develop an assessment rubric guided by the Lasater Clinical Judgment Rubric (LCJR) to assess nursing students' clinical reasoning skills in encounters with semi-linear virtual patients, and B) to test the newly developed rubric's abilities to capture nursing students' clinical reasoning processes during virtual patient simulation.

IV   To determine the psychometric properties of the virtual patient version of the Lasater Clinical Judgment Rubric (vpLCJR).

4   METHODS

The method section will initially report on aspects that apply to all studies, after which the method characteristics for each study will be presented.

The overarching aim of this thesis was to increase knowledge about how to model virtual patients for the use of teaching and learning clinical reasoning for nursing students, and how to assess different aspects of nursing students' competence in clinical reasoning in the encounter with virtual patients. To address the research aim, the general approach was to apply a nonexperimental explanatory sequential mixed methods case study design (Creswell & Plano Clark, 2011). An overview of methods applied for studies I-IV is presented in Table 1.

Table 1. Overview of methods applied in this thesis.

Study	Focus of inquiry	Study approach	Participants	Data collection	Data analysis
I	Develop a model and learning activity	A two phase design; Development	Faculty members (n=18)	Discussions	Theoretical analysis Validity test
	Student perceptions	Quantitative	Nursing students (n=50)	Questionnaire	Descriptive statistics
II	Students experience	Qualitative – quantitative Cross-sectional	Nursing students (n=125)	Students' written reflections	Quantitative-qualitative manifest content analysis
			Nursing students (n=250)	Questionnaire	
III	Developing a rubric for assessing.	Two phase design. Mixed-methods	Nursing students (n=125)	Students' written summary statement and reflections	Abductive analysis Qualitative deductive content analysis
	Testing the rubric		Faculty members (n=15)	Discussions, written feedback	Descriptive statistics Validity test
IV	Examine the psychometric properties of the rubric	Quantitative Psychometric	Nursing students (n=125)	Students' written summary statement and reflections	Deductive content analysis Exploratory factor analysis

4.1   Empirical Context

The empirical context for studies I–IV was the nursing education programme at Karolinska Institutet, a medical university in Stockholm, Sweden. In Sweden, nursing education is a three-year programme, corresponding to 180 credits that lead to a Degree of Bachelor of Medical Science with a Major in Nursing. The study programme in nursing includes both theoretical and clinical courses (Råholm et al., 2010), and approximately half of the time is dedicated to clinical courses.

4.2   Format of the Virtual patients in the studies

In this study we used two virtual patient platforms, Virtual Interactive Case system (VIC) (Figure 3) (Zhou, Taite, Sandhu, Steiman, & Lake, 2018) and Web SP (Figure 4) (Zary, Johnson, Boberg, & Fors, 2006).
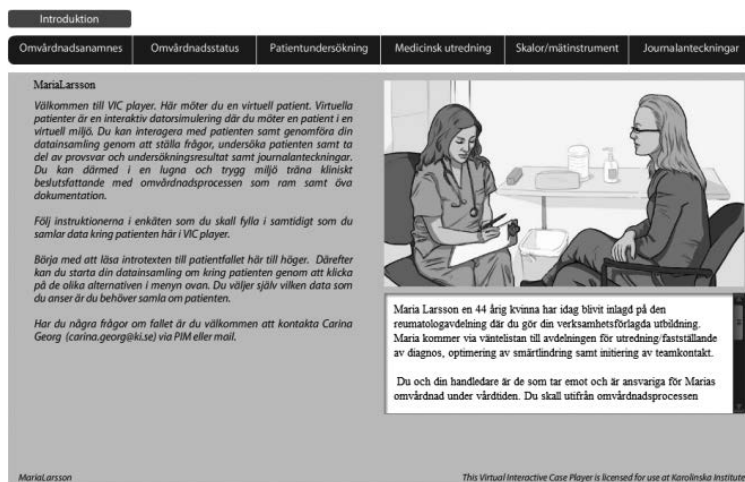

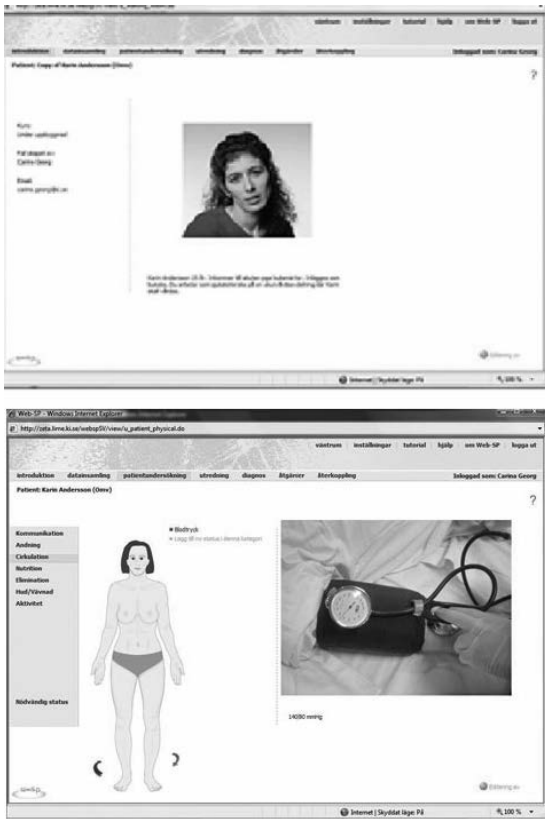***Figure 3.*** *Screenshot of a virtual patient example from the VIC system.*

Figure 4. Screenshot of a virtual patient example from the WebSP system.

In the virtual patient platform, the learners are presented with a patient scenario and they have the opportunity to interact with the virtual patient through the computer. The overarching design of the virtual patient is modelled on an encounter between a virtual patient and a nurse, including a stepwise unfolding of the case. The case begins with the patient presenting their complaint. The students then collect data by patient interview, conducting physical examinations and medical investigations, and reading patient medical and nursing records in order to obtain an understanding of the patient's narrative, situation and nursing care needs (Figure 5).
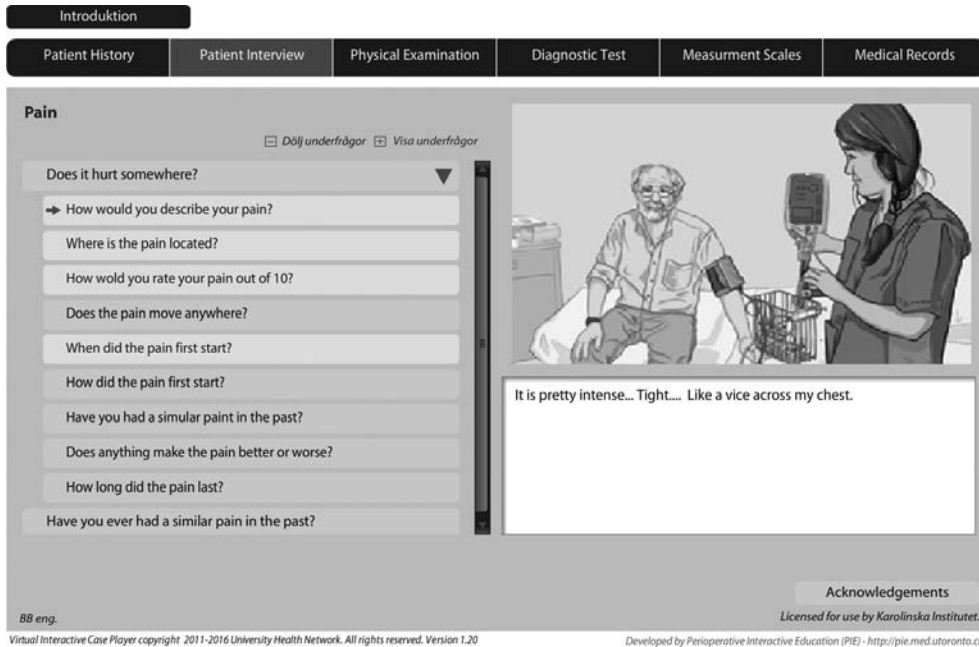
Figure 5. Screenshot of an example of a virtual patient in the Virtual Interactive Case (VIC) system. The case begins with a slide where the patient presents the complaint and where the context of the case is explained. The software allows the student to interact with the patient by conducting a patient interview in order to obtain a patient history and ask functional assessment questions. The students can also conduct functional assessments, order appropriate laboratory tests and read health records etcetera in order to gain an understanding of the patient's narrative. The patient assessment is carried out by selecting items from a menu of question's or actions in each category (patient interview etc.), with a tab for each category, and submenus under each tab to group items within the tab. Questions can have follow-up questions which are revealed after the initial question is selected. The results of the learners' actions can be presented in text, images, sound, videos or animated patient monitors.

As in patient encounters, the students can carry out their assessment in any order they choose. Both systems were exploratory and semi-linear in design which means that they enable free navigation between the different sections for data collection (for example patient interview, physical examination and diagnostic tests) (Huwendiek, de Leng, et al., 2009; Zhou et al., 2018).The design of the virtual patient cases used in the different studies was based on the on the *virtual patient Nursing Design Model* (vpNDM) (Georg & Zary, 2014). This model is described in greater detail in Section 6.1. In the virtual environment, the nursing students were presented with a virtual scenario in which they had the opportunity to interact with a virtual patient and collect data in order to obtain an understanding of the patient's situation and nursing care needs. During the encounter with

the virtual patient, the students answered questions (Appendix 1), inspired by the OPT model (Kautz et al., 2005; Kuiper et al., 2017; Pesut & Herman, 1998, 1999). To answer these questions, the students were prompted to write free-text short summary statements.

4.3 Participants

This thesis primarily employed a purposive sampling strategy, to increase the likelihood that the participant could provide varied and rich information relating to the phenomenon of interest (Creswell, 2007; Duan, Bhaumik, Palinkas, & Hoagwood, 2015) i.e. virtual patient in nursing education.

4.3.1 Study I

In the developing and validation phase, 18 faculty members from different educational contexts (nursing, education and clinical) with different experience of teaching clinical reasoning were invited to participate. In all, 18 faculty members participated.

In order to investigate how nursing students perceived the model a purposeful sample (Creswell, 2007) of 102 nursing students was invited to take part in the study. The students were second-year students participating in a medical-surgical nursing course that included both theoretical and clinical parts. All students had completed four virtual patient cases in a learning activity. In all, 50 nursing students participated in this study.

4.3.2 Study II

In study II we used two different settings. In one setting students used virtual patients as a part of a learning activity, and in the other setting, students used virtual patients as a part of a high stake summative assessment.

In the learning activity setting, all second-year students (n=130) participating in a medical-surgical nursing course including virtual patients as part of a learning activity were invited to take part in the study. In all, 125 students agreed to take part in the study. Each student completed two virtual patient cases, resulting in 250 cases.

In the high stake summative assessment setting, all third-year students (n=1050) participating in a high stake summative assessment were invited to take part in the study. In all 752 students agreed to participate and answered questions about the examination. Of these, 250 nursing students also answered free-text questions about the virtual patient case. These free-text answers comprised the data for this part of the study.

4.3.3 Study III

In the development of the rubric, all students (n=102) who had interacted with a virtual patient case developed in the virtual interactive case system (VIC) (Toronto General Hospital, 2017; Zhou et al., 2018) were invited to take part in the study, 97 agreed to take part in the study. In phase two,- testing the rubric, 28 nursing students who had interacted with virtual patient cases developed in the Web-SP system (Zary et al., 2006) were invited and were included in the study.

In order to check the validity of the developed rubric faculty members' with experiences of research in nursing or medical education or teaching clinical reasoning were invited to participate. In all, 15 faculty members participated.

4.3.4 Study IV

In study IV, all 130 second-year nursing students participating in a learning activity including two virtual patients were invited to take part in the study. In all, 125 students participated in the study, and 125 students participated in each scenario, resulting in a total of 250 valid cases.

4.4 Data collection

In the following section, approaches and evaluation tools used in order to collect data for the four studies included in the thesis will be presented. The data collection was guided by the overall aim of the thesis, the objective for each study and the results from previous studies.

4.4.1 Study I

The focus for study I was to design a model for virtual patients aimed at nursing education, and to investigate how this model could be instantiated as a learning activity and explore students' perceived usefulness of virtual patients developed from that model.

4.4.1.1 Review of theories

In order to understand which aspects of clinical reasoning should be present in a virtual patient model, a review of existing theoretical frameworks regarding clinical reasoning relevant to nursing education was carried out.

4.4.1.2 Faculties perspectives

To understand how to theory anchor the virtual patients and create virtual patients, faculty members were involved as a reference group. Data was collected through

discussions and written feedback. An iterative approach was used and interaction with the participants was conducted through several occasions. Field notes were documented the same day as the discussions were conducted.

4.4.1.3 Students' perspectives – the eVIP questionnaire

To assess students' perceived usefulness of the learning activity and the encounter with the virtual patients, a validated questionnaire that had been translated into Swedish was used (see Appendix 2). The questionnaire: " Student questionnaire concerning their learning and clinical reasoning experiences with virtual patients", focuses on students' experiences of learning and the development of clinical reasoning skills (Huwendiek et al., 2015). The questionnaire was developed for different student groups in medical education. However, in the questionnaire the word "doctor" was replaced with "nurse".

4.4.2   Study II

The focus for study II was to examine how nursing students described their experiences of using virtual patients, in a learning activity and as a part of a high stake summative assessment.

4.4.2.1 Students' text from a learning activity

The data consisted of summary statements and reflections that students produced during a learning activity including virtual patients. The learning activity was based on the virtual patient activity model and included two different virtual patients (Figure 6) based on the virtual patient nursing design model (vpNDM), developed in study I (Georg & Zary, 2014) and is described in greater detail in section 6.1.

In the virtual environment, the nursing students were presented with a virtual scenario in which they had the opportunity to interact with a virtual patient and collect data in order to obtain an understanding of the patient's situation and nursing care needs. During the interaction, the students answered question relating to the OPT model (Kautz et al., 2005; Kuiper et al., 2017; Pesut & Herman, 1998, 1999) and the intended learnings goals (Appendix 1). To answer these questions, the students were prompted to write free-text short summary statements and reflections. Once the students had completed the task in the learning activity, they immediately received formative feedback on their performance. The students were then asked to use this feedback to write reflections about their learning during the learning activity and their experiences of working with the virtual patient cases. The students' reflections on their learning comprised the data for this study.

Case one illustrated a woman in her 40s who had been admitted to a ward with a 6-month history of pain related to rheumatoid arthritis. The nursing diagnosis for this patient was related to pain and readiness for enhanced comfort as well as insomnia, impaired physical mobility and risk of impaired skin integrity.

The second case illustrated an older man diagnosed with type 2 diabetes, who had been admitted to a ward with hyperglycaemia, heart failure, and an acute diabetic foot. The nursing diagnosis for this patient was related to the risk of unstable blood glucose level, excess fluid volume, impaired gas exchange, impaired skin integrity, ineffective self-health management and deficient knowledge.

Figure 6. *Case one and Case two. The students completed the first virtual patient case at the beginning of the course and the second case at the end of the course.*

4.4.2.2 *Questionnaire from the summative high stake assessment*

In order to collect data about how nursing students described their experiences of using virtual patients, in the context of a high stake summative assessment, the students were asked to answer a questionnaire (Appendix 3) immediately after completing a summative high stake assessment. The students conducted this examination of professional competence during their final semester. It is a written, digitalised case-based examination including virtual patients, aiming to assess knowledge and clinical reasoning skills. Three hours are allocated for the examination, which takes place in a lecture hall equipped with one computer at each seat. The computer is locked with safe exam browser, allowing internet access for certain pre-defined websites such as the virtual patient cases. The examination is based on a modified essay question structure (Palmer & Devitt, 2007) and consists of three different patient cases, of which one is a virtual patient based on vpNDM. All cases are constructed to represent commonly occurring patient healthcare disorders and nursing care needs across the lifespan.

The questionnaire included both quantitative Likert-type questions and open-ended questions. The answers from the open-ended questions comprised the data part of study II.

4.4.3 Study III

The focus for study III was to develop an assessment rubric guided by the Lasater Clinical Judgment Rubric (LCJR) aiming to assess nursing students' clinical reasoning skills in encounters with semi-linear virtual patients, and to test the newly developed rubric's ability to capture nursing students' clinical reasoning processes during virtual patient simulation.

4.4.3.1 *Review of theories*

In order to understand which aspects of clinical reasoning should be present in an assessment instrument aiming to assess nursing students clinical reasoning during encounters with virtual patients, a review of existing theoretical frameworks regarding clinical reasoning relevant to nursing education was carried out.

4.4.3.2 *Development of the rubric*

In order to develop the rubric, text written by students in the learning activity described above (4.4.2.1) working with virtual patients created in the VIC software were analysed. Only texts from the second case (the elderly man) were analysed.

4.4.3.3 *Test of the new rubric*

Faculty members (n=15), were involved as a reference group. Data was collected through discussions and written feedback, and field notes were documented on the same day as the meetings.

In order to test the rubric, texts written by the students (n=28) in the learning activity described above (4.4.2.1) working with virtual patients created in the WebSP software were analysed. Only texts from the second case (the elderly man) were analysed.

4.4.4 Study IV

The focus for study IV was to determine the psychometric properties of the virtual patient version of the vpLCJR. In this study, the students interacted with two different virtual patients in a learning activity. The students completed case one at the beginning of the course and case two at the end of the course. Between scenarios one and two, the students carried out a six-week clinical training period, on a ward at a hospital. In the learning activity, the students interacted with and collected data from the virtual patients. During their encounters with the virtual patients, the students were prompted to write free-text short summary statements and reflections in order to answer questions (n=15) based on the OPT model aiming to unfold the clinical reasoning process in a stepwise manner (Appendix 1).

4.5 Data analysis

In this section different qualitative and quantitative methods that were used to analyse the data will be presented.

4.5.1 Study I

Study I, investigated which aspects of clinical reasoning should be present in a virtual patient model and how the model should be represented as a learning activity. In order to understand which aspects need to be highlighted in order to clarify nursing aspects in a virtual patient simulation, a review of theoretical frameworks regarding educational models for teaching and learning clinical reasoning in nursing education were conducted. The Outcome - Present State -Test (OPT) model (Kautz et al., 2005; Pesut & Herman, 1998) was chosen as a theoretical foundation for the development of the virtual patient model. The reason for this was that this model is evidence-based and widely claimed to support teaching and learning of clinical reasoning in nursing. In order to design a model optimised for virtual patients in nursing education, a multidisciplinary team used an iterative approach to design the model and virtual patients' cases based on this model. Faculty members tested

and validated the design of the model, the design of the learning activity and the virtual patient cases in terms of both the relevance of chosen theories and applicability to highlight clinical reasoning in a nursing context.

In order to answer the research questions regarding how nursing students perceived the usefulness of virtual patients as an artefact of the developed models, quantitative data from the eVIP questionnaire were analysed using SPSS®. Descriptive statistics were performed. Cronbach's alpha was calculated to provide an overall reliability coefficient for the set of questions included in the study. Item-total statistics were examined to check whether any item was inconsistent with the others, and could thus be discarded. An item-item correlation matrix was observed to examine the correlation between the items.

4.5.2   Study II

In order to answer the question about how nursing students described their experience of using virtual patients in the context of learning activities and high stake summative assessment, a quantitative-qualitative content analysis (Karlgren, 2016) of students' written reflections about their experiences of virtual patients was conducted. Content analysis is an empirically grounded method that can be defined as a research technique for making replicable and valid interferences from data through an iterative, systematic coding process. The research technique provides new insights and expands the understanding of the area of interest (Krippendorff, 2013). The analysis in study II was performed by utilising the Gavagai Explorer (https://explorer.gavagai.se) text analysis program developed for analysing large amounts of text data. This tool was used to conduct meaning-based text analytics that build on text clustering and topic extraction. It allows for a qualitative descriptive analysis combined with quantification of data (Espinoza et al., 2018; Parks, Karlgren, & Stymne, 2017). Gavagai Explorer performs an analysis of the manifest content by automated interactive lexical text clustering, quantifying and calculating occurrence of topics in the text (Espinoza et al., 2018). The tool processes the dataset in order to identify common topics according to term specificity in language. Gavagai Explorer also helps the analyst by suggesting a list of topics based on associated termsand sentiment scores, and ranking the topics based on occurrences in the text (Espinoza et al., 2018; Parks et al., 2017). In order to dig deeper into the text data, terms and topics can be ignored or merged. Terms that do not contribute to any topics can be deleted, but the text data will remain in the dataset allowing them to instead contribute to other topics. The analysis was performed in four steps. An overview of the analysis process is presented in Figure 7.

Understanding the content of the data

- The text data was read and re-read several times in order to obtain an understanding and familiarity with the content.

Preparation of the data

- To prepare the data to be analysed in Gavagai Explorer, all text was saved in a comma-separated values (CSV) file.
- Gavagai Explorer

Analyses in the Gavagai Explorer

- The text was analysed with an iterative approach in multiple occasions, clustering the text into topics using Gavagai Explorer. In each iteration, the text was analysed to define topics by semantically clustering similar terms in the text. The clustering builds on term specificity in the language to select which term to use as clustering features. Gavagai Explorer also sorts the topics by quantifying the topics in descending orderr based on occurrences/frequencies in the texts

Refine the analysis

- After each iteration, the new clustering was scrutinised and further refined. New topics and terms were added, closely related topics were merged and topics and terms that were irrelevant for the aim were discarded (e.g., in the first iteration the topic "*virtual patients*" was suggested but was not considered useful as virtual patients was the overall topic of the analysis). After each iteration, Gavagai Explorer automatically re-calculated the strength of the topics and suggested new topics and new associated terms for the revised topics
- This process continued until a collective agreement about the topics was reached in the research team
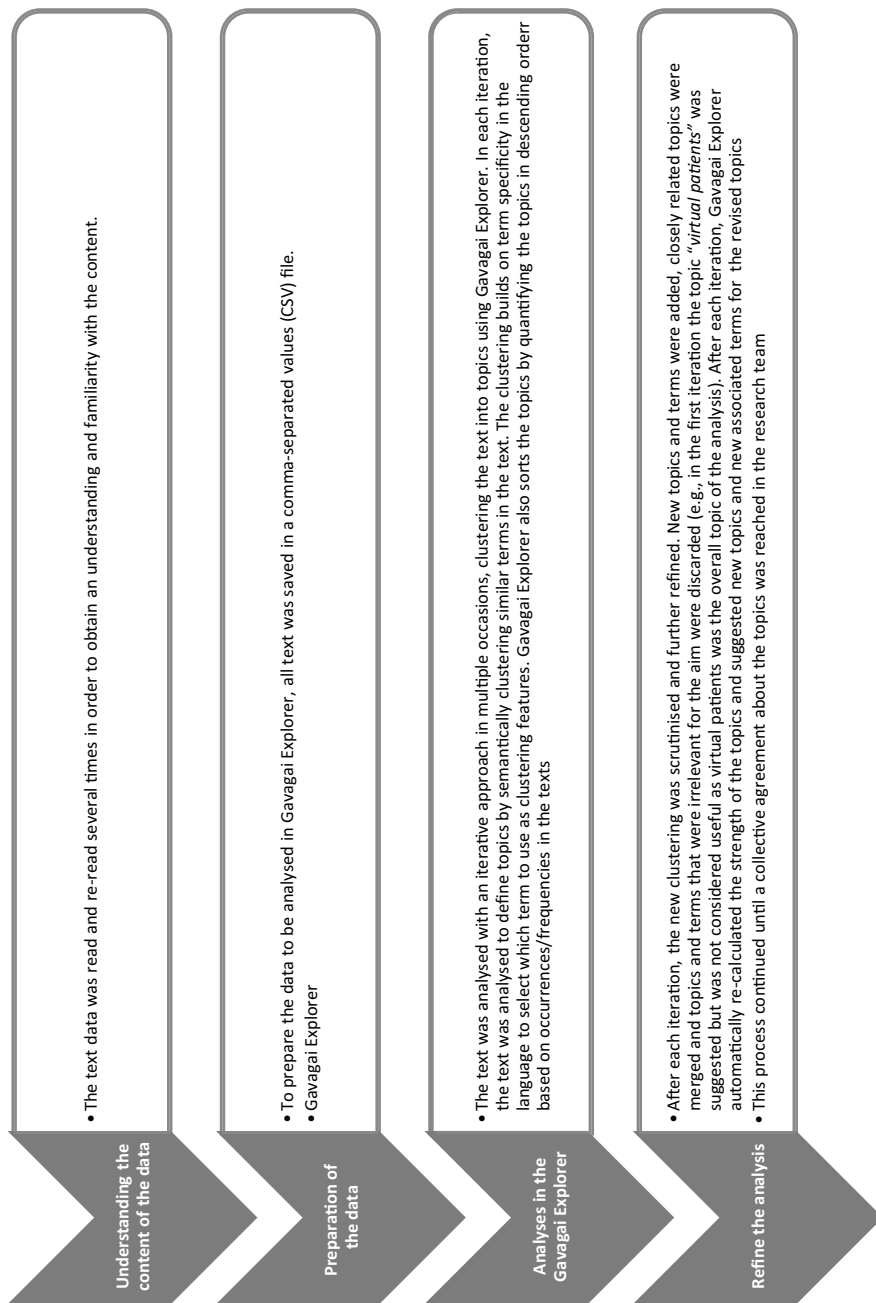
Figure 7. An overview of the four steps of the analysisprocess of study II.

4.5.3 Study III

In order to understand how clinical reasoning is assessed in other simulation modalities, we started to review research in the field. The Lasater Clinical Judgement Rubric (LCJR) (Lasater, 2007), based on the conceptual framework of Tanner's clinical judgment model (Tanner, 2006), was chosen to serve as a model for developing a rubric aiming to assess nursing students clinical reasoning in the encounter with virtual patients. The LCJR is used by educators in nursing education for assessing cognitive, affective and psychomotor aspects of nursing students' clinical reasoning when encountering high-fidelity simulation using human-like manikins (Davis & Kimble, 2011; Jensen, 2013; Lasater, 2011; Nielsen, Lasater, & Stock, 2016). The rubric is validated and has been used for both educational and research purposes (Adamson et al., 2012; Ashcraft et al., 2013; Jensen, 2013; Kardong-Edgren, Adamson, & Fitzgerald, 2010; Victor-Chmil & Larew, 2013). The rubric has also been modified for different educational contexts (Kristiansen, Häggström, Hallin, Andersson, & Bäckström, 2015; Miraglia & Asselin, 2015; Román-Cereto et al., 2018; Hyunsook Shin, Gi Park, & Shim, 2015; Vreugdenhil & Spek, 2018).

In order to investigate which aspects of clinical reasoning included in the Lasater Clinical Judgment Rubric (LCJR) (Lasater, 2007) were applicable in the context of virtual patients and which content needed modifications, a qualitative deductive content analysis (Elo & Kyngäs, 2008) was performed, using phases, dimension and development descriptors of the LCJR as a lens and coding scheme.

In order to modify items that did not cover clinical reasoning aspects expressed in virtual patient encounters, an abductive analysis (Tavory & Timmermans, 2014; Timmermans & Tavory, 2012) was performed. Abductive analysis consists of an iterative process of open/axial coding and alternative casing by going back and forth between the rubric, data and analytic memos. In order to understand the data, discover patterns and relationships within the finding, the team used an iterative process and tested alternative codes and dimensions. Data was analysed word by word, paragraph by paragraph in order to formulate as many links and hypotheses in the light of theoretically positioned knowledge as possible. This theoretical coding and dialogue with the data continued until saturation was reached.

In order to validate the new rubric, faculty members (n=15) validated the rubric. In order to test the usability and utility of the new rubric, students' performance during the virtual patient encounter (i.e. the free-text short summary statements and reflections students composed when working through the learning activity) was analysed by conducting a deductive content analysis (Elo & Kyngäs, 2008), using phases, dimension and development descriptors of the new rubric as a lens and coding scheme. After the deductive content analysis was finalised, the result were quantified according to Lasater's (2007) description and a statistical analysis including descriptive statistic and Cronbach's alpha was calculated using SPSS®.
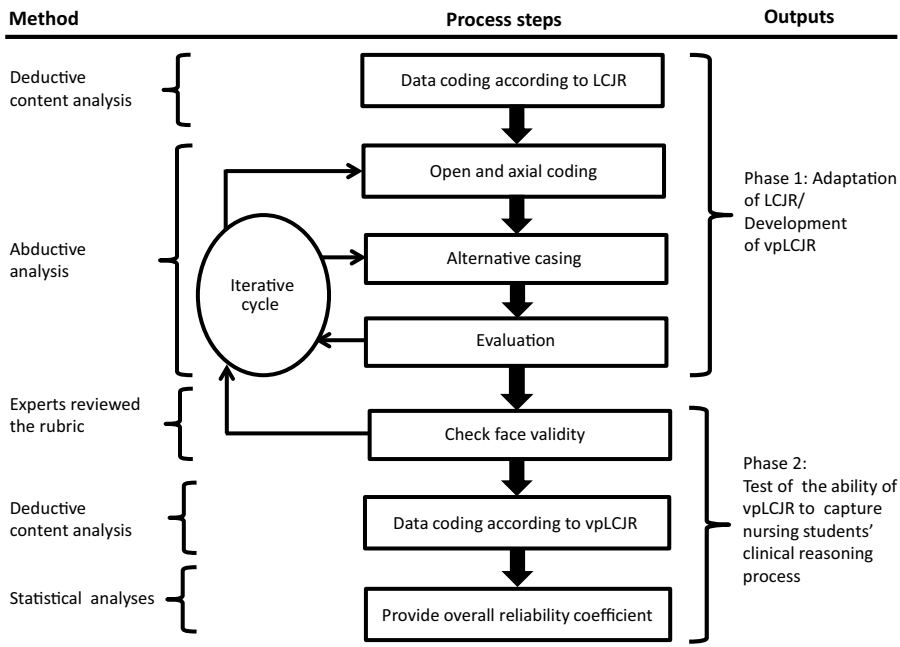
Figure 8. *An overview of t the analysisprocess of study III.*

4.5.4   Study IV

In order to investigate the validity and reliability of the rubric developed in study III, the psychometric properties of the rubric were investigated. The analysis was conducted in two steps. Students' text from the learning activity with the virtual patients was analysed with a deductive content analysis (Elo & Kyngäs, 2008), using the phases, dimension and development descriptors of the new develop rubric; the virtual patient LCJR (vpLCJR) was used as a lens and predefined coding categories. The vpLCJR is described in greater detail in section 6.3. In the second step, these results were quantified according to Lasater's (2007) description and statistically analysed using SPSS®. The items were analysed on three levels- individually, overall and pooled. Descriptive statistics including means and standard deviation were calculated. To test factorability, the Kaiser-Meyer-Olkin test (value of sampling adequacy) and Bartlett's test (of Sphericity) were conducted. To test if the population was normally disturbed, Shapiro-Wilk's test was performed. The internal consistency of vpLCJR was calculated using Cronbach's alpha. The psychometrics of the rubric were examined using exploratory factor analysis (EFA) (Flora & Flake, 2017). Discriminative ability of the vpLCJR was examined using categorical variables. Principal axis factoring (PAF) (Reio & Shuck, 2015) was used to understand latent structures and patterns of correlation among individual attributes of the rubric.

5   ETHICAL CONSIDERATIONS

In the present research project, ethical aspects have been considered in different ways. An application to the Regional Ethical Review Board in Stockholm (EPN) resulted in a statement from the review board concluding that the Swedish Ethical Review Act was not applicable as the project did not involve processing of sensitive information. A positive advisory statement in accordance with sections 4a and 4b of the Statute (2003:615) concerning the Ethical Review of Research Involving Humans was obtained from the ethical review board. The research was conducted according to the Declaration of Helsinki (2013). Nevertheless, taking part in a research study can affect the participants' lives, integrity and autonomy and in order to minimise such potential risks it is a fundamental principle to conduct ethically sound research.

The principle of **privacy** and **anonymity** is an essential ethical principle in research. In this research project, **confidentiality** was ensured through the confidential processing of data and by not making data attributable to any identifiable individual. The data from the learning activities were anonymised and a coding system was applied to protect individual identities. The data from the participants in the summative assessment were also anonymised and untraceable (i.e. it was not possible for the research team to identify participants). All data was saved on external, securely stored hard disks. Only the PhD student and the research team had access to the data.

The principle of **voluntary** participation of respondents in research is another important ethical aspect to consider. The participants in the learning activity were informed both orally and in writing about the purposes of the research. Each of the prospective participants then signed informed consent forms, which clearly stated that their participation was voluntary and that they could withdraw at any time. Five students declined to participate and of those who agreed, none ended their participation at a later stage. For the assessment part in study II, data were collected retrospectively from the summative assessment. However, it was not possible to identify participants and the data was not retrieved until approval from the ethical review board had been obtained.

Another important issue that was considered relates to **dependency** and to the inherent power relationships that exist in the university setting. The participants were students in the nursing programme and both the PhD student and some members of the research team were employed as teachers on the nursing programme. To minimise the risk of students feeling forced to participate in the research, students were informed that the researchers were not able to identify individual students' answers and that the researchers would not be involved in any assessment or grading of the students.

6   FINDINGS

The overall aim of this thesis was to increase knowledge about how to design virtual patients for the use of teaching, and learning clinical reasoning for nursing students, and how to assess different aspects of nursing students' competence regarding clinical reasoning in encounters with virtual patients. In the following chapter, a summary of the main results of each of the four studies is presented. These are: the development and application of a virtual patient model optimised for high-lighting clinical reasoning in nursing (Study I), exploring students' experiences of learning and assessment using virtual patients developed in the model in study I (Study II), the development and application of an instrument with the capacity to assess nursing students' clinical reasoning in encounters with virtual patients (Study III) and the validation of the instrument developed in study III (Study IV).

6.1   Study I

The starting point for this thesis was curiosity about how to highlight clinical reasoning from a nursing perspective in virtual patients. The focus for study I was the development and application of a virtual patient model optimised for highlighting clinical reasoning in nursing. In line with this, the project started to investigate which aspects of clinical reasoning should be present in a virtual patient nursing model adapted for nursing education. We then investigated how such a virtual patient nursing model could be represented as a learning activity. Finally, we explored how nursing students perceive their learning of clinical reasoning when using virtual patients based on the virtual patent model.

A model called the virtual patient Design Nursing Model (vpDNM) was developed. This model is aimed to provide a structure for teachers when authoring virtual patients intended for nursing education. The vpNDM builds on the Outcome-Present State-Test (OPT) model, also called the 3rdgeneration nursing process. This is a model for patient-centred clinical reasoning in nursing (Kautz et al., 2005; Kuiper et al., 2017; Pesut & Herman, 1998, 1999). The OPT model is an iterative, non-linear recursive information-processing model that suggests strategies to help nurses in the clinical reasoning process (Kautz et al., 2005).

The vpNDM model (Figure 9) is composed of three main layers. Layer 1 (the patient centred narrative layer), is the patient-centric data collection layer. This layer suggest different sources of data that should be included in a virtual patient in order to help the student to reason about data gathering and consider what information they need to collect, in order to understand the patient in context story. To capture the patient-centred narrative, the students need to learn to collect both

subjective and objective data from various sources. Layer 2 (the clinical reason-ing process layer), is the iterative clinical reasoning layer. This is about specific thinking strategies and tactics that support the development of clinical reasoning competence. In the model, students answer questions that help students to filter, frame and focus their clinical reasoning. Layer 3 (the outcome layer), suggests measurable outcomes when using virtual patients developed via this model.
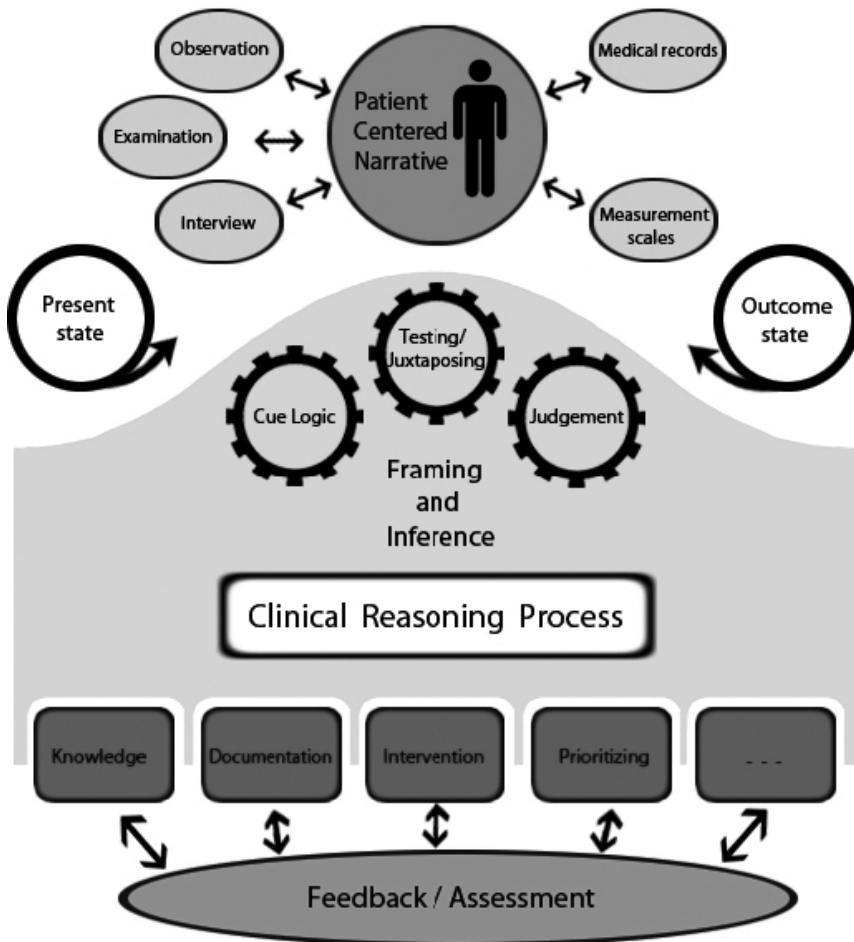

Figure 9. *The virtual patient Design Nursing Model (vpDNM).*

The vpDNM was then contextualised in a learning activity, and the virtual patient Nursing Activity model (vpNAM) was developed (Figure.10). This model suggests a design for learning activities including virtual patients. The vpNAM takes into account drivers of learning in scenario-based e-learning as that the case serve a context for learning, it is holistic with variable chunks, the learner takes on a role and are expected to resolve task in relation to the case, the instructional approach is indicative and build on learning from experience, it is interactive with con-sequential feedback (Colvin Clark, 2013).
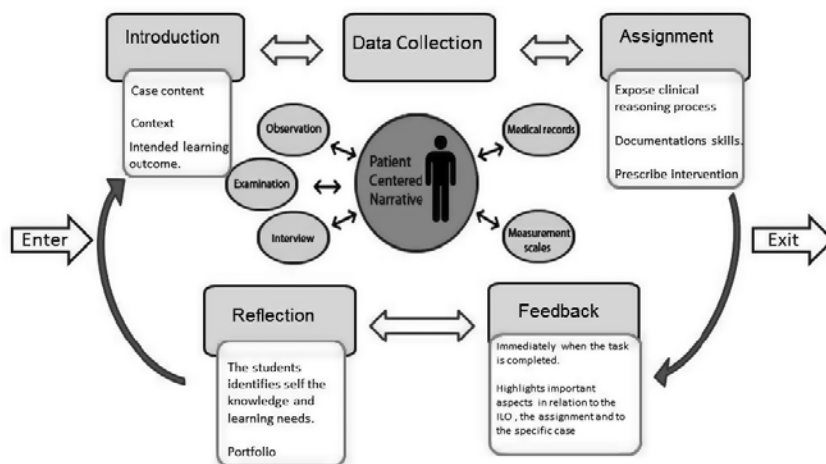

Figure 10. The virtual patient Nursing Activity Model (vpNAM)

6.2 Study II

Study II focused on exploring nursing students' experiences of using virtual patient simulation, based on the vpNDM. In this study, students interact with virtual patients in the context of learning activates and in the context of high-stake summative assessment.

The analysis identified seven topics reflecting students' experiences of the use of virtual patients in the context of learning activities (see Figure 11), and four topics reflecting students' experience of virtual patients used in the context of summative high-stake assessment (see Figure 12).

Most students seemed to find it appropriate to use virtual patients for learning. Approximately 90% of the nursing students expressed that they experienced the learning activity as being helpful as a stimulus for self-analysis of learning. They expressed that the learning activity helped them to identify strengths and weak-nesses in their knowledge and competence as well as target areas for improvement.
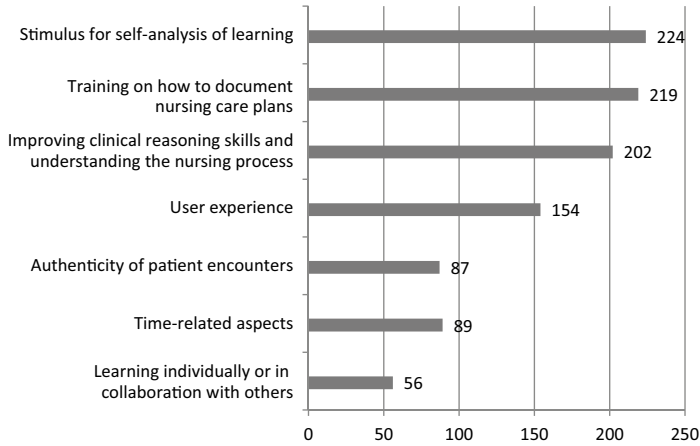
Figure 11. Topics reflecting students`experience of virtual patient in the contect of learning activites.
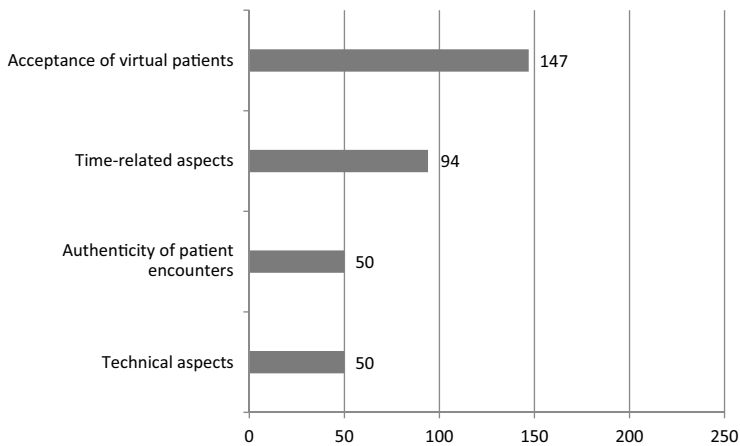
Figure 12. Topics reflecting students' experiences of virtual patients in the context of summative assessment.

"This learning activity with virtual patients has been interesting and fun, I feel that I have learned a lot. I think I have good grasp of how to document patient history, admission assessment, nursing diagnosis and nursing goals in the nursing care plan, but I still feel a bit uncertain when it comes to nursing interventions. I think I lack knowledge in pathological physiology…"

About 88% of the students expressed that they experienced the virtual patient simulation as useful for training nursing documentation and creating nursing care

plans. They expressed that the activity provides an opportunity to practice using standardised terminologies when documenting patient care.

"Through these patient cases, I had the opportunity to train and reflect on my ability to organise nursing documentation, and that has developed my documentation skills."

Students (87%) also expressed that the virtual patient simulation supported them in developing clinical reasoning competence and encouraged them to reflect on the nursing process. Students appreciated that the virtual patient cases provided practical examples of how to formulate sensitive questions and how to interact with patients in order to collect relevant data.

"The nursing process became clearer to me, what is included in each step of the process and how I as a nurse should think during the planning and implementation of a nursing care plan. It was a great help as a nurse that I was able to ask different questions and choose which information I needed to collect. It became clear after a while what information I needed…"

About 62% of the students mention that they experienced the virtual patient simulation as an engaging, motivating and meaningful learning activity.

"I think it is a suitable and instructive way to look at a patient case."

The virtual patient cases were perceived as realistic and students expressed that they experienced authenticity in the patient encounter. Students also expressed that they could easily relate virtual patient cases to real life caring situations. A few of the students expressed that they had difficulties relating to real life patients due to the fact that they perceived the virtual patient as unrealistic. These students expressed that they lacked the ability to read the patient body-language, facial expressions and tone of voice.

"… this virtual patient case was very authentic, and I was easily able to relate it to reality. I could relate to the nursing process and tried to think of the patient as a patient I was caring for in real life."

Approximately 30% of the students raised time-related aspects. Some students appreciated that they could spend more time on virtual patients compered to patients in real life, and other students expressed that the virtual patient cases were too time consuming.

"The patient case is a good learning experience, because one has time to evaluate and go back to the case while referring to the literature. In reality, it can be more stressful and not as relaxed."

Students expressed different preferences regarding working through the virtual patient cases single-handedly or in collaboration with others. Some students appreciated the opportunity to immerse themselves in cases without being disturbed by others. Other students expressed that they lacked reflections from co-workers.

"...I was able to sit down without any stress and reflect on what is important without having a supervisor to ask. I alone had to decide what was most important."

"Something that complicated the process was that one works alone and I missed the opportunity and the time to think together with others."

Students' written reflections in the questionnaire distributed after the summative high-stake assessment focused mainly on the assessment (e.g. the structure and the time), with only 250 students mentioning the virtual patient cases. Of these students, 147 expressed an acceptance and appreciation of the use of virtual patients in relation to assessment.

"Virtual patient cases are always nice, because you're required to think more on your own and you get the opportunity to choose the information you think is relevant, instead of being 'served' a complete patient case."

Students who had a more critical approach to virtual patients in the context of assessment mainly referred to time-related aspects. They highlighted that it takes time to assess a virtual patient in order to create an understanding of the patient's story and situation. Therefore, students emphasised that the additional time-consuming task needs to be considered when designing the assessment.

"I liked that the case gave an overall picture, but it was time-consuming and if you want to deliver good quality it was too extensive, especially for those of us who read slowly."

Also in the context of assessment, students (20%) stated that they experienced virtual patients as authentic and that they were able to relate to care situations in real life. None of the students expressed that they experienced virtual patients as unrealistic or that they had difficulties relating to real life situations.

"The issues focused on in this patient case were relevant and it felt authentic. It felt as if this was a real patient and it was therefore well designed."

Technical aspects brought up by the students, included that the combination of using virtual patients together with MEQs was perceived as challenging.

"Virtual patient cases are difficult in modified essay question assessments."

6.3   Study III

This study focuses on how to assess students' clinical reasoning abilities in encounters with virtual patients. An assessment instrument, aiming to assess nursing students' clinical reasoning skills in encounters with virtual patients was developed. The new rubric, the virtual patient version of the Lasater Clinical Judgment Rubric (vpLCJR) (Georg, Karlgren, Ulfvarson, Jirwe, Welin, 2018) was based on Lasater Clinical Judgement Rubric (Lasater, 2007) , which is based on the conceptual framework of Tanner's clinical judgment model (Tanner, 2006). The LCJR was developed to be used in the simulation laboratory context, using high fidelity manikins (Lasater, 2007). In this study, the LCJR was adapted to assess nursing students' clinical reasoning in the encounter with virtual patients. Modification from LCJR was made with the permission of Professor Kathie Lasater.

Both LCJR and vpLCJR consist of specific dimensions within Tanner's (2006) four phases of clinical reasoning: noticing, interpreting, responding and reflecting. In the rubrics, each phase is divided up and described in two to four dimensions that elucidate the meaning of each phase. Each dimension is also delineated with development descriptors for four development levels: beginning, developing, accomplished and exemplary. The rubric is published in (Georg, Karlgren, Ulfvarson, Jirwe, Welin, 2018)

The "Noticing" phase addresses clinical reasoning aspects enhanced in virtual patient simulation. Therefore, there was no need for adaptation in this phase. Table 2 demonstrates the noticing phase in vpLCJR.

The "Interpreting" phase was to a large extent well aligned with interpreting aspects' raised in virtual patient encounters. However, some aspects that address how the students frame the story of the patient were added to vpLCJR. Table 3 demonstrates the interpreting phase in vpLCJR.

The "Responding" phase was totally remodelled. In the LCJR, the responding phase addresses affective and psychomotor aspects, which are not applicable in the encounter with virtual patients. However, virtual patient, are well suited to addressing aspects about how to establish a nursing health record, use standardised terminologies, plan for care and communicate this care plan. Table 4 demonstrates the responding phase in vpLCJR.

The "Reflecting" phase highlights both reflection in and on action. There was no need for adaptation in this phase. Table 5 demonstrates the interpreting phase in vpLCJR.

6.4   Study IV

The focus for this study was to determine the psychometric properties of the virtual patient version of the vpLCJR.

The exploratory factor analysis, indicates that the original four phases in the original LCJR rubric could be reduced to three phases in the context of virtual patient simulation (see Table 6 and Figure 13). These three factors: "understanding the patient, "care planning" and "reflecting", explained 82% of the variance.

Table 6. Exploratory factor analysis. All 11 items loaded strongly (>60) to one factor, no item cross loaded.

Phases and dimensions of clinical reasoning	Factor 1 Understanding the patient	Factor 2 Care planning	Factor 3 Reflecting
NOTICING			
Focused observation	.835	.213	.202
Recognizing deviation from Expected patterns	.855	.266	.140
Information seeking	.822	.304	.224
INTERPRETING			
Prioritizing data	.858	.256	.158
Making sense of data	.737	.377	.134
RESPONDING			
Documentation; initial patient status/nursing history	.642	.485	.164
Identifying nursing diagnoses and desired patient outcomes	.284	.851	.178
Well-planned intervention	.335	.861	.173
Being skillful	.369	.862	.187
REFLECTING			
Evaluation/ self-analysis	.248	.198	.869
Commitment to improvement	.155	.164	.908

Extraction method: Principal competence t analysis. Rotation method: Varimax with Kaiser normalization, rotation converged in five iterations.
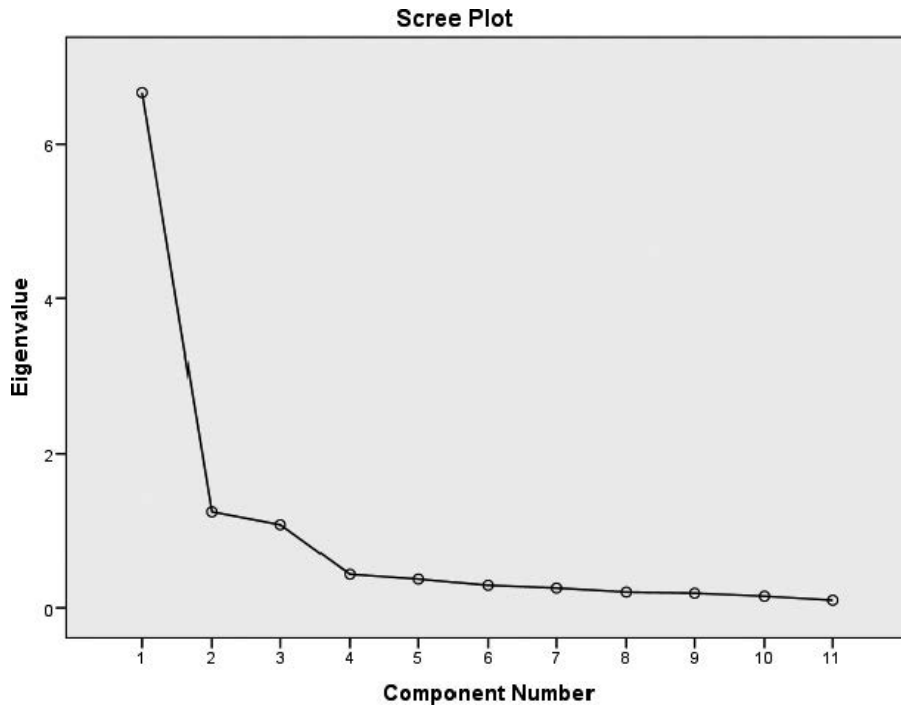
Figure 13. *Scree plot of the factor loading.*

Cronbach's alpha was .931, indicating consistent reliability for the vpLCJR (see Table 7). Students responses were distributed across all development descriptors, indicating that it is feasible to use the rubric to capture different aspects of nursing students' clinical reasoning during encounters with virtual patients.

Table 7. Cronbach's alpha (α) for each item and in total.

Phases of clinical reasoning	Dimensions of clinical reasoning	α
NOTICING		**.907**
	Focused observation	.923
	Recognising deviation from expected patterns	.923
	Information seeking	.921
INTERPRETING		**.860**
	Prioritising data	.922
	Making sense of data	.924
RESPONDING		**.912**
	Documentation; initial patient status/nursing history	.923
	Identifying nursing diagnoses and desired patient outcomes	.925
	Well-planned intervention	.923
	Being skillful	.921
REFLECTING		**.835**
	Evaluation/self-analysis	.931
	Commitment to improvement	.936
TOTAL		**.931**

7   DISCUSSION

The overall aim of this thesis was to increase knowledge about how to design virtual patients for the use of teaching and learning clinical reasoning for nursing students, and how to assess different aspects of nursing students' competence regarding clinical reasoning in encounters with virtual patients. The four studies included in this thesis build upon each other sequentially, and have captured aspects of using virtual patients for learning and assessing nursing students' clinical reasoning skills in different ways. Studies I and II address how to design virtual patients in order to focus on clinical reasoning in nursing and how students described their experience of using virtual patients based on the developed model. Studies III and IV address how to assess nursing students' clinical reasoning in encounters with virtual patients. Figure 14 illustrates the main findings from the four studies included in this thesis.
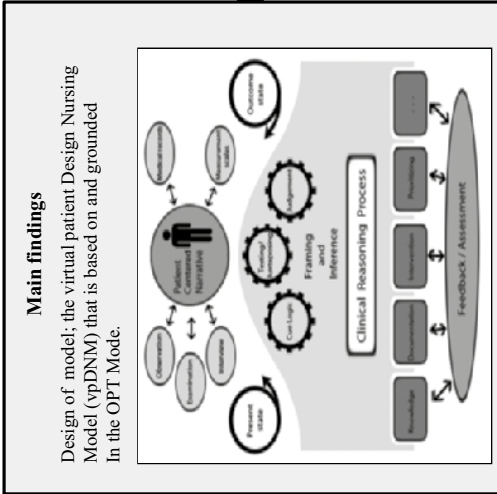
7.1   Design of virtual patients to highlight clinical reasoning in nursing

Clinical reasoning is considered to be a primary skill in nursing practice and an essential competence for nursing students to develop during their education. Effective and efficient clinical reasoning is a decisive competence in order to perceive good standards of patient care and promote patient safety (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Benner et al., 2009; Jessee & Tanner, 2016). Nevertheless, nursing education seems to fall short of providing learning opportunities to develop competence in clinical reasoning (Benner, 2012; Theisen & Sandau, 2013). Teaching and learning clinical reasoning is a complex process that combines knowledge, skill, experience, and intuition. The most common way of training clinical reasoning is to expose students to clinical settings. One challenge is to ensure that students are exposed to different situations of appropriate duration, diversity and quality (Jimenez, 2017; Menezes, Corrêa, Silva, & Cruz, 2015). The modality of virtual patients has been proposed as a cost-effective tool to facilitate and assess the development of students' clinical reasoning (Cook et al., 2010). However, there is a lack of research on how to design virtual patients that aim to foster nursing students' clinical reasoning. There is also a lack of theory-anchored models for designing virtual patients. This is, however, not specific to learning activities using virtual patients; theoretical bases that support other learning activities to assist clinical reasoning are also lacking (Menezes et al., 2015).

In this study, a theory-anchored virtual patient model optimised for learning and assessing nursing students' clinical reasoning was developed. This virtual patient Design Nursing Model (vpDNM) aims to provide a blueprint and a structure for faculties in nursing education when authoring virtual patients intended to highlight

Design virtual patients to highlight clinical reasoning in nursing

Assessment of clinical reasoning

Development and application a model

Main findings

Design of model; the virtual patient Design Nursing Model (vpDNM) that is based on and grounded In the OPT Mode.

Explore students' experiences

Main findings

Seven topics reflecting students' experience of the use of virtual patients in the context of learning activities and four topics in the context of assessment was identified. Overall students seems to value virtual patients' abilities to visualise clinical reasoning.

Topics reflection students experiences of the use of virtual patients

The context of learning activities	The context of summative assessment
Stimulus for self-analysis of learning	Acceptance of virtual patients
Training nursing documentation and creating nursing care plan	Time-related aspects
Improving clinical reasoning and understand the nursing process	Authenticity of patient encounters
User experience	Technical aspects
Authenticity of patient encounters	
Time-related aspects	
Learning individually or in collaboration with others	

Development and application of a rubric

Main findings

A rubric the virtual patient version of LCJR (vpLCJR), aimed to be used when assessing nursing students' clinical reasoning competences in encounters virtual patients was developed. The LCJR is based on Lasater Clinical Judgement Rubric and the conceptual framework of Tanner's clinical judgment model. Below is an illustration of phases of domains constituting the core of the rubric.

Phases of Clinical reasoning	Dimensions of clinical reasoning
NOTICING	Focused observation
	Recognizing deviation from expected patterns
	Information seeking
	Prioritizing data
	Making sense of data
INTERPRETING	Documentation; initial patient status/nursing history
RESPONDING	Identifying nursing diagnoses and desired patient outcomes
	Well-planned intervention
	Being skilful
REFLECTING	Evaluation/self-analysis
	Commitment to improvement

Validating the rubric

Main findings

The findings show that the vpLCR can be used for objective assessment of clinical reasoning in virtual patients encounters. The results also indicate that the rubric has ability to capture both levels and progress of students clinical reasoning. The result also indicate that vpLCJR is both valid and reliable.

The result form the factor analysis indicate that the four phases in vpLCJR could be reduced to three factors.

Phases of Clinical reasoning	Dimensions of clinical reasoning
UNDERSTANDING THE PATIENT	Focused observation
	Recognizing deviation from expected patterns
	Information seeking
	Prioritizing data
	Making sense of data
	Documentation; initial patient status/nursing history
CARE PLANNING	Identifying nursing diagnoses and desired patient outcomes
	Well-planned intervention
	Being skilful
REFLECTING	Evaluation/self-analysis
	Commitment to improvement

Figure 14. Overview of the main findings.

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clinical reasoning in nursing education (Georg & Zary, 2014). The vpNDM model is based on the Outcome-Present State-Test model (OPT). The OPT model is a widely acclaimed, iterative, nonlinear, recursive information-processing model for teaching and learning patient-centred clinical reasoning in nursing (Kautz et al., 2005; Kuiper et al., 2017; Pesut & Herman, 1998). To my knowledge, no study has previously developed a virtual patient model based on a model for clinical reasoning in nursing. One study, however, has developed a framework that aims to enhance clinical reasoning in the context of medical education (Hege et al., 2018).

The results from paper I and paper II demonstrated that the participants responded in a positive way towards the virtual patients design based on the vpNDM model. The students stressed that they perceived using virtual patients as parts of the learning activity as a worthwhile learning experience (Georg & Zary, 2014). This resonates well with research on virtual patients (Huwendiek, 2016; Pantziaras, 2015). Students also expressed that the virtual patient simulation was helpful as a means for self-analysis of learning and to identify progress over time. Further research is, however, needed in this area. The students seem to perceive virtual patient activities especially useful for training nursing documentation, creating nursing care plans and training to use standardised nursing terminology. Furthermore students also express that they appreciated training with virtual patients for understanding and applying the nursing process as well as training clinical reasoning. There is a lack of evidence-based strategies for teaching and learning documentation skills during nursing education (Greenawalt, 2014). Training to write summary statements in the format of health care records is one way to train problem presentation and integrating experiences into an organised network of knowledge that can be effectively applied in future clinical reasoning (Bowen, 2006). Virtual patients seem to be well suited for training students to write summary statements (Berman et al., 2016; Heist, Kishida, Deshpande, Hamaguchi, & Kobayashi, 2016; Smith et al., 2016). Virtual patients have been used to train communication skills and creating summary reports in the form of SBAR reports (Fleiszer et al., 2017; Peddle et al., 2018), but to my knowledge have not been used to train the writing of nursing care plans using standardised nursing terminology.

The results of studies I and II also demonstrated that students perceived the virtual patient simulations to be authentic in both the learning activity and the assessment activity. Furthermore, the students stressed that they could easily relate to the virtual patients as real patients and that they felt a responsibility for the patients. This is in line with other research surrounding virtual patients and authenticity (Duff, Miller, Bruce, Msa, & Anp, 2016; Huwendiek, 2016; Pantziaras, 2015; Urresti-Gundlach et al., 2017). The results indicate that it is important that the case presentations are personalised and tell a story about a patient and also mimic real life clinical situations. Further research is needed to investigate the concept of authenticity in relation to virtual patients.

The incorporation of theory-based questions that guided the clinical reasoning experience was perceived as helpful by the majority of the students. Students indicated that this "coaching" helped them "demystify" the nursing process and visualise the clinical reasoning process. There are still many unanswered questions concerning the nature of dual processing reasoning (non-analytical and analytical) in relation to virtual patients (Cook et al., 2010; Hege et al., 2018; Schubach et al., 2017). The hypothesis is often that virtual patients support the acquisition of non-analytical (system 1) clinical reasoning skills by teaching pattern recognition mechanisms, through exposing learners to large numbers of patient cases (Cook and Triola, 2009). Nevertheless, the results from this study indicate that "forcing" junior students to carry out analytical reasoning by enhancing a stepwise solving of the case may help the students to apply an analytical (system 2) process of clinical reasoning. This guidance can help students in elucidating the clinical reasoning process, develop their reflective skills and thereby increase their clinical reasoning abilities.

7.2   Assessment of clinical reasoning

In the search for an answer to the question of how to assess nursing students' clinical reasoning during encounters with virtual patients, focus was turned to the development of a rubric, the virtual patient version of Lasater's Clinical Judgment Rubric (vpLCJR) (Georg, Karlgren, Ulfvarson, Jirwe, Welin, 2018).

A rubric is an assessment instrument that articulates the expectations for an assignment by listing performance criteria and describing the levels of performance quality (Davis & Kimble, 2011). Students' competence in clinical reasoning is often assessed using global ratings. The use of rubrics has the potential to transform the often subjective global rating assessment into a more objective evaluation (Fleiszer et al., 2017). Furthermore, the use of rubrics can help learners to understand what is expected of them as well as promoting continuity and consistency among teachers. Another benefit of rubrics is that they facilitate communication by providing students and faculty with a mutual language to foster discussion about the meaning of clinical reasoning. The Lasater Clinical Judgment (LCJR) is a validated rubric that is widely used to assess nursing students' clinical reasoning/ judgment in their encounters with manikin simulation (Lasater, 2007). LCJR is based on the conceptual framework of Tanner's Clinical Judgment Model (Tanner, 2006). Our hypothesis was that combining the LCJR in encounters with manikin simulations in combination with the vpLCJR in the encounters with virtual patient simulations would support students in developing clinical reasoning skills.

Due to the fact, that manikin simulation and virtual patient simulation facilitate different learning experiences and address different learning goals (Cant & Cooper, 2017), modification of the rubric was necessary. The vpLCJR is designed to assess

nursing students' clinical reasoning according to Tanner's four phases of clinical reasoning/judgment: *noticing, interpreting, responding* and *reflecting*. The phase that required the most extensive modification was the responding phase. Each phase in the rubric is further described in two to four dimensions (a total of 11 dimensions), which are clinical performance indicators that elucidate the meaning of each phase. The eleven dimensions are also delineated by development descriptors consisting of four distinct developmental levels: beginning, developing, accomplished, and exemplary, with descriptive statements for each of the four levels (see Table 2, 3, 4 and 5).

Data show that vpLCJR has the ability to capture different aspects, as well as strengths and flaws in nursing students' clinical reasoning process. The data also showed that it is possible to assign each student to one of the four development levels, indicating that the vpLCJR has the potential to be useful for evaluating nursing students' progress regarding the development of clinical reasoning. Furthermore, the data also indicate that the vpLCJR is able to facilitate an objective assessment of students' clinical reasoning skills and may facilitate feedback and feedforward to the students. Further research is however needed to investigate the students' experience of this kind of feedback and feedforward.

In terms of psychometric data, the results show that the vpLCR has acceptable validity and reliability. Cronbach's alpha was 0.931, indicating consistent reliability. The exploratory factor analysis suggested that the vpLCJR may consist of three factors rather than the four proposed by Tanner's model. The suggested factors, which were named: "Understanding the patient", "Care planning" and "Reflecting" explained 81.8% of the variance. The new factors are in line with the OPT model of clinical reasoning. However, since all items in the vpLCJR are based on Tanner's model and the Cronbach's alpha values were high, removing items or changing the phases was not considered.

7.3   Methodological considerations

A strength with this research is that all four studies were conducted in authentic educational settings, which enhances the value of the findings for educational practice. On the other hand, one limitation is that all four studies emanate from undergraduate nursing students at a single university. The possible uniqueness of this university's curriculum may affect the generalizability of the findings to other settings. However, the study was performed at a large university including many students using virtual patients both in learning activities and in high-stake summative assessments. Another limitation is that the sample size could affect the generalizability of the thesis. More analyses with larger samples would be beneficial in the future.

One limitation that may affect the reflexivity is that the PhD student conducting this thesis also is a faculty member, using virtual patients for teaching and assessment in the nursing education program at the university. This may have led to biases in the design, data collection and analysis in various ways. To increase the confirmability or the objectivity these aspects were discussed and addressed in the research team. To prevent biases because of the PhD student's and the research team's pre-understandings and to increase awareness of pre-conceptions and interpretations, the findings were discussed and evaluated with faculties in two different institutions and with experience from various contexts. Moreover, the findings were reported and discussed with researchers at scientific conferences. However this pre-understanding about nursing education and use of virtual patients for teaching and assessment of clinical reasoning can also be viewed as a strength since it contributed to a greater understanding of its complexity.

Furthermore, in this thesis different research methods were used. Blending methods in a thesis provides multiple angles to the issues under scrutiny. In addition, to use different methods for analysing already familiar material requires a process of stepping back and becoming aware of one's pre-understanding and earlier interpretations. In study II a new tool, the Gavagai Explorer, was used to perform a qualitative-quantitative content analysis (Espinoza et al., 2018; Karlgren, 2016; Parks et al., 2017). A strength of Gavagai Explorer is that the tool enables content analysis of large amounts of text and structures the content analysis around what was actually expressed by the respondents and thereby avoiding that the analysis wanders off in directions that is not warranted by the raw data. In study III abductive analysis (Tavory & Timmermans, 2014; Timmermans & Tavory, 2012) was used to modify items to frame clinical reasoning emerge from virtual patient simulation. To the best of my knowledge, this is the first time that this method is used to adapt a rubric to a new context.

Another possible limitation is that the virtual patient model vpNDM and the rubric vpLCJR only was tested in correlation to explorative semi linear virtual patients (an instructional design effecting how the learners navigate through the case) (Huwendiek. et al., 2009). Still both the vpNDM and the vpLCJR may have potential to be used with branched virtual patients as well.

Another possible limitation is that the interrater reliability of educators using the vpLCJR was not assessed.

8   CONCLUSIONS

A conclusion based on the results from studies I and II is that virtual patients are well suited for teaching learning and assessment of nursing students' clinical reasoning skills. The results propose that the application of the outcome present state model is suitable in the context of virtual patients. Using theory-anchored virtual patients adapted for nursing education could support nursing students' development of clinical reasoning by making the process thinking strategies and tactics used in reflective clinical reasoning more explicit. Virtual patients can also be used for teaching and learning documentation of patient care and accurate use of standardized terminologies in patient records. Furthermore, the results also suggest that a virtual patient based on the vpNDM is well suited to be used in formative and summative assessment as well as offer nursing students' valuable opportunities for self-assessment and for identifying target areas of improvement.

A main conclusion based on the results of studies III and IV is that assessment with vpLCJR can be used to assess different aspects as well as levels and progress of the nursing students' clinical reasoning. The vpLCJR provides both students and educators with a defined set of performance criteria. The results indicate that such performance criteria can help students understand what is expected of them and thereby promote learning and promote continuity and consistency among teachers. It is also shown that the rubric has the potential to be used as a valid assessment instrument to assess nursing students' clinical reasoning when encountering virtual patients.

We conclude that virtual patients can be a valuable tool in teaching, learning and assessing nursing students' clinical reasoning. The vpLCJR can be used in nursing education setting to assess various aspects of nursing students' clinical reasoning during encounters with virtual patients.

8.1   Implications

It is important that nursing students and nurse educators have a mutual under-standing of the concept of clinical reasoning to be able to identify its presence and foster its development. Nursing faculty are required to design learning activities and develop learning environments that actively engage students in the process of constructing their own understanding. This thesis expands the knowledge about teaching, learning and assessment of clinical reasoning when using virtual patients. Using a theory-anchored model when designing virtual patients may aid constructive alignment with intended learning objectives. The vpNDM can be used as a theory-anchored blueprint and thereby serve as designed guidelines for teachers when constructing virtual patients aimed for training or assessment

of clinical reasoning during nursing education. This may contribute to more systematic development of virtual patients and thereby facilitate exchange of virtual patients across different contexts and technical solutions.

Furthermore, there is a lack of validated instruments for the objective assessment of nursing students' clinical reasoning capabilities during encounters with virtual patient encounters. The vpLCJR deconstructs different aspects of clinical reasoning, and provides students and faculty members with a mutual parlance. This may foster feedback, discussion and a collective understanding about the concept of clinical reasoning and thereby promote learning and enhance objective assessment of students' clinical reasoning abilities.

8.2   Future research

A study conducted over a longer period would increase understanding of strengths and limitations of virtual patient design depending on the students' competence profiles. Identification of strengths and weaknesses can lead to the development of targeted teaching strategies directed towards improving clinical reasoning. In addition, in order to explore how students and educators perceive the strengths and limitations of virtual patients developed based on the vpNDM model, a qualitative study using semi-structured interviews could illuminate different perspectives. Such research could provide a more nuanced understanding of how virtual patients can be enhanced to be more effective learning resources. In order to investigate if the findings from this thesis can be transferred to other settings, it would be interesting to extend the research to a multicenter study. Future studies should also examine the interrater reliability of educators using the vpLCJR. Furthermore, it would be interesting to implement a simulation program, using both virtual patient simulation and manikin based simulation, i.e. conducting a formative assessment using vpLCJR (for the virtual patient simulation) and the LCJR (for the manikin based simulation) and then examine the impact of this training on students' development of clinical reasoning in real clinical encounters. To have a valid and reliable tool to assess clinical reasoning in both manikin and virtual patient simulation and clinical encounters has important implications. Knowledge about how performance in simulations transfers to the practice setting validates simulation as a learning strategy. It can also be a means of assessing students' competence in transferring theoretical scientific knowledge into clinical reasoning during patient-related practice with the ultimate goal of improving patient care.

9   SWEDISH SUMMARY – SVENSK SAMMANFATTNING

Sjuksköterskors förmåga till kliniskt resonemang har stor betydelse för kvaliteten på omvårdnad och patientsäkerhet. Ett viktigt mål för sjuksköterskeutbildningen är därför att blivande sjuksköterskor tillägnar sig kunskaper i kliniskt resonemang. Studier visar dock att det kan vara en utmaning för sjuksköterskestudenter att träna kliniskt resonemang och en utmaning för lärare att skapa lärandeaktiviteter som synliggör för studenter vad kliniskt resonemang innebär och som ger feedback till studenterna gällande deras styrkor och förbättringsområden. Tidigare studier visar att användning av virtuella patienter (interaktiva datorsimuleringar av verkliga kliniska scenarier i utbildnings- eller undervisningssyfte) är ett kostnadseffektivt tillvägagångssätt för att träna och bedöma studenters förmåga till kliniskt resonemang. Trots att virtuella patienter har använts under många år i olika sjukvårdsutbildningar saknas det fortfarande kunskap om hur man kan utforma virtuella patienter för att underlätta lärandet av kliniskt resonemang inom omvårdnad för sjuksköterskestudenter samt hur man kan göra rättssäkra och rättvisa bedömningar av studenternas kliniska resonemang. Det övergripande syftet med avhandlingen har varit att bidra med ökad kunskap om hur man kan designa virtuella patienter för att tydliggöra kliniskt resonemang inom omvårdnad samt hur man kan bedöma kvalitén på studenternas kliniska resonemang när de arbetar med virtuella patienter. Avhandlingen bygger på fyra delstudier.

I **delstudie I** designades en modell för att skapa virtuella patienter som synliggör kliniskt resonemang inom omvårdnad. Modellen bygger på den tredje generationens omvårdnadsprocess. En modell för kliniskt resonemang där sjuksköterskan reflekterar och utför omvårdnad utifrån identifiering av patientens nuvarande hälsotillstånd och det önskvärda förväntade hälsotillståndet. Utifrån denna modell skapades virtuella patientfall som används för lärande och examination. I **delstudie II** undersöktes hur studenterna uppfattade att arbeta med virtuella patientfall utvecklade utifrån modellen utvecklad i delstudie I. Resultaten analyserades med hjälp av en kvantitativ-kvalitativ innehållsanalys. I **delstudie III** utvecklades en bedömningsmatris för att kunna synliggöra olika aspekter av sjuksköterskestudenters kliniska resonemangsförmåga vid läraktiviteter med virtuella patienter. För detta ändamål modifierades LCJR (Lasater clinical judgment rubric), en bedömningsmatris som tidigare använts för att synliggöra sjuksköterskestudenters kliniska resonemang och beslutsfattande i samband med fullskalesimulering. Den nya matrisen, kallad vpLCJR, utvecklades genom abduktiv analys. I **delstudie IV** utfördes en psykometrisk analys av bedömnings matrisen utvecklad i studie III.

Resultatet av denna avhandling visar att teoriförankrade virtuella patienter är lämpliga att använda vid undervisning och bedömning av kliniskt resonemang. Studenterna ansåg att virtuella patientfall gav stöd i lärandet och gav mer komplexitet och autenticitet till bedömningssituationen. Resultatet visar även att bedömnings-matrisen har förmåga att observera studenternas kliniska resonemangsförmåga när de arbetar med virtuella patientfall.

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Instrumentet för att synliggöra studentens kliniska resonemang samt instruktioner för lärandeuppgiften till studenterna

(frågor som studenten skall besvara är markerade med kursiv stil)

Öppna en ny flik till internet och klistra in följande webbadress:
Du kan också klicka direkt på länken för att öppna sidan. Läs introduktionstexten (texten i den vita rutan under bilden).

- *Efter att ha läst Introduktionstexten till patientfallet så tror jag att Maria Larssons problem handlar om? Med andra ord skall du formulera en hypotes om vad du tror är Maria Larssons omvårdnadsproblem.*

- *Motivera varför du tror att detta är Marias omvårdnadsproblem.*

- *Under datainsamlingen tror jag att jag behöver undersöka följande aspekter. Med andra ord, vad anser du att du behöver samla in för data om Maria. Motivera ditt svar.*

Gå nu tillbaka till det virtuella patientfallet Maria Larsson och påbörja din datainsamling.

Instruktion till datainsamlingen

Du kan samla en hel del data kring patienten. Viss information är nödvändig men viss information är ej relevant för detta tillfälle. Syftet är inte att du skall välja samtliga frågor eller undersökningar, utan att du skall välja den data som du finner intressant och nödvändig att få svar på för att kunna se Marias omvårdnadsbehov. Du kan röra dig fritt bland undersökningsformerna, alla val kan göras och alla frågor kan ställas i vilken ordning som helst.

Vid de fall där det syns en knapp med en halvkropp i den nedre delen av skärmen, kan du få fram en annan bild om du trycker på den knappen. För att komma tillbaka till huvudmenyn (efter att du har tittat på bilden) så trycker du på det stora röda korset.

Under **Omvårdnadsanamnes** intervjuar du patienten om dennes bakgrund. Välj en frågegrupp i rullmenyn, och ställ de frågor du finner relevanta, exempelvis: När startade dina problem? Svar får du direkt.

Under **Omvårdnadsstatus** frågar du ut patienten om dennes tillstånd inom olika områden Välj område i rullmenyn och ställ de frågor du finner väsentliga.

Under **Patientundersökning** undersöker du patienten fysiskt. Välj undersökningsområde i rullmenyn.

Under **Medicinsk utredning** kan du beställa prover och undersökningar inom olika områden. Välj i rullmenyn. Beställ de undersökningar du finner lämpliga.

Under **Skalor/mätinstrument** finner du olika bedömningsinstrument som används inom omvårdnad. Du får själv räkna ut patientens poäng (utifrån data som du samlar in under omvårdnadsstatus och patientundersökning) och göra en riskbedömning. För att få fram bedömningsinstrumenten måste du klicka på knappen med en halvkropp i den nedre delen av bilden.

Under **Journalanteckningar** kan du ta del av olika yrkesgruppers journalanteckningar.

- *När du nu har genomfört en första datainsamling om Maria, har du förändrat din hypotes kring vilka omvårdnadsbehov Maria har? Motivera varför.*

- *Behöver du ytterligare information om Maria? I så fall vad? Motivera varför.*

- *Har du använt dig av bedömningsinstrument? Varför/Varför inte? Motivera ditt svar.*

- *Finns det bedömningsinstrument som du anser kan vara lämpliga att använda för att bedöma Marias omvårdnadsbehov? Motivera ditt svar.*

Om du anser att du behöver samla mer data om Maria så går du tillbaka till det virtuella patientfallet Maria och forsätter din datainsamling.

- Du har nu gjort en datainsamling. Utifrån den fakta du nu har samlat om Maria så journalför du din omvårdnadsbedömning i form av omvårdnadsanamnes och omvårdnadsstatus enligt VIPS. (Du kan när du vill gå tillbaka till det virtuella patientfallet och samla in mer/kompletterande data.)

- *Journalför omvårdnadsanamnes enligt VIPS.*

- *Journalför omvårdnadsstatus enligt VIPS.*

- *Vilka omvårdnadsproblem anser du att Maria har? Motivera ditt svar.*

- *Utifrån de omvårdnadsproblem du ser ska du journalföra tre omvårdnadsdiagnoser som du anser är relevanta för Maria. Om möjligt ska omvårdnadsdiagnoserna skrivas utifrån NANDA.*

- *Motivera varför du har valt dessa tre omvårdnadsdiagnoser att arbeta med.*

- *Formulera omvårdnadsmål relaterade till de omvårdnadsdiagnoser som du har valt.*

- *Motivera varför du anser att dessa omvårdnadsmål är lämpliga.*

- *Ordinera omvårdnadsåtgärder enligt VIPS, relaterade till dina omvårdnadsdiagnoser.*

- *Motivera varför du anser att dessa omvårdnadsåtgärder är relevanta.*

- *Saknar du uppgifter/data i patientfallet?*

- *Känns fallet realistiskt? Varför/Varför inte? Motivera*

Tack för att du har genomfört uppgiften!

Du är nu klar med del 1 i patientfallet.

Klicka på följande länk återkoppling Maria Larsson och du får en direkt feedback på patientfallet. Läs feedbacken och jämför svaren mot dina egna svar. Feedbacken är förslag från fallskaparen och inte ett direkt facit. Detta innebär att du skall läsa feedbacken och reflektera över vad du redan kan och vad du har ytterligare inlärningsbehov kring.

Reflektion över eget lärande:

Efter att ha läst feedbacken kommer del två i uppgiften.

Del två innebär att du skriver en reflektion om ditt eget lärande. Denna reflektion sparas här samt i portfolien (du får själv lägga in din reflektion i portfolien).

Stödfrågor till när du skriver din reflektion:

- *Vad har du lärt dig?*

- *Vad har du upptäckt att du redan kan?*

- *Vad ser du att du har ytterligare inlärningsbehov kring?*

- *Har du förvånats över något?*

- *Har det virtuella patientfallet bidragit till ditt lärande och i så fall hur?*

- *Saknar du något som skulle ha underlättat i ditt lärande?*

- *Hur kan du använda de nya kunskaperna i ditt framtida yrke som sjuksköterska?*

Skriv dina reflektioner i nedanstående ruta. Klistra också in reflektionen i ett worddokument och spara i din portfolio. Du kommer att jobba vidare med denna reflektion i nästa patientfall.

Student questionnaire concerning their learning and clinical reasoning experiences with virtual patients

Authors: *Sören Huwendiek[1] and Bas de Leng[2] in cooperation with the eViP Project Team[3].*

About this questionnaire

This questionnaire is for students to evaluate their experiences with virtual patients, focusing on the development of clinical reasoning skills.

This questionnaire contains 14 items clustered into seven subsets. This instrument can be repeatedly administered to elicit student's experiences immediately following each workshop or 'play' of a virtual patient.

Please respond using the following 5-point scale:

1) Strongly disagree
2) Disagree
3) Neutral
4) Agree
5) Strongly agree
6) Not applicable

Please indicate briefly the reason(s) for your response for each question (optional).

Example:
While working on this case, I felt as if I were the doctor caring for this patient.

Strongly disagree - Strongly agree   Not applicable

1   2   3   4   5
6

Why (if you agree):

Why not (if you disagree):

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1. Centre for Virtual Patients, University of Heidelberg Medical School, University of Heidelberg
2. Department of Educational Development and Research, Faculty of Health, Medicine and Life Sciences, Maastricht University
3. www.virtualpatients.eu

Authenticity of patient encounter and the consultation
1. While working on this case, I felt I had to make the same decisions a doctor would make in real life.

2. While working on this case, I felt I were the doctor caring for this patient.

Professional approach in the consultation
3. While working through this case, I was actively engaged in gathering the information (e.g., history questions, physical exams, lab tests) I needed, to characterize the patient's problem.

4. While working through this case, I was actively engaged in revising my initial image of the patient's problem as new information became available.

5. While working through this case, I was actively engaged in creating a short summary of the patient's problem using medical terms.

6. While working through this case, I was actively engaged in thinking about which findings supported or refuted each diagnosis in my differential diagnosis.

Coaching during consultation
7. I felt that the case was at the appropriate level of difficulty for my level of training.

8. The questions I was asked while working through this case were helpful in enhancing my diagnostic reasoning in this case.

9. The feedback I received was helpful in enhancing my diagnostic reasoning in this case.

Learning effect of consultation
10. After completing this case, I feel better prepared to confirm a diagnosis and exclude differential diagnoses in a real life patient with this complaint.

11. After completing this case I feel better prepared to care for a real life
patient with this complaint.

Overall judgment of case workup

12. Overall, working through this case was a worthwhile learning
experience.

Open-ended questions

13. Special strengths of the case:

14. Special weaknesses of the case:

15. Any additional comments:

3

Enkät 1 handlar om Henry Nordin

Vilken *relevans* bedömer Du att fallet har i förhållande till kunskapsmålen för sjuksköterskeexamen?

○   5 fullständig relevans (1)

○   4 mycket stor relevans (2)

○   3 stor relevans (3)

○   2 liten relevans (4)

○   1 mycket liten relevans (5)

○   0 saknar relevans (6)

Vilken *svårighetsgrad* anser Du att fallet har med hänsyn till vad som kan vara rimligt för sjuksköterskeexamen?

○   6 alltför hög svårighetsgrad (1)

○   5 mycket hög svårighetsgrad (2)

○   4 hög svårighetsgrad (3)

○   3 lagom svårighetsgrad (4)

○   2 låg svårighetsgrad (5)

○   1 mycket låg svårighetsgrad (6)

○   0 alltför låg svårighetsgrad (7)

Tacksam för Dina fritt formulerade kommentarer till fallets konstruktion och innehåll.

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