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Original research

Psychometric properties of the virtual patient version of the Lasater Clinical Judgment Rubric

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ABSTRACT

A number of studies attest to the effectiveness of virtual patients in fostering and assessing students' development of clinical reasoning. An objective assessment of students' clinical reasoning is, however, challenging. This study focused on determining the psychometric properties of the virtual patient version of the Lasater Clinical Judgment Rubric, a rubric that is aimed at assessing nursing students' clinical reasoning processes when encountering virtual patients. A nonexperimental design was used in which data from 125 students' reflections on solving two different virtual patient scenarios were included in the analysis. First, a deductive content analysis was conducted using the categories of the rubric as a lens. After that, each student's performance was quantified according to the different levels of the rubric. Exploratory factor analysis and test of normality and reliability, including the Kaiser-Meyer-Olkin test, Bartlett's test, the Shapiro-Wilk test, and Cronbach's alpha were used in the analysis. The result suggested three factors: "Understanding the patient", "Care planning" and "Reflecting" that explained 81.8% of the variance. Cronbach's alpha was 0.931. The result showed the rubric to be a valid assessment instrument for assessing nursing students' clinical reasoning when encountering virtual patients.

1. Introduction

Clinical reasoning is a basic skill and a cornerstone competency of nursing practice. Therefore, nursing students' development of clinical reasoning skills is a major goal of the nursing education system (Hunter and Arthur, 2016; Jessee and Tanner, 2016). Supporting nursing students to develop appropriate clinical reasoning skills is nevertheless a challenge for the education system (Pennaforte et al., 2016) and educators struggle with how to teach and evaluate nursing students' clinical reasoning abilities (Delany and Golding, 2014; Pinnock and Welch, 2014). Virtual patients have been acknowledged as well suited for teaching, learning and assessing health-care students' development of clinical reasoning skills (Cook and Triola, 2009; Cook et al., 2010; Hege et al., 2016). An objective assessment of students' clinical reasoning is however challenging, and most current methods for formative evaluation of health-care students' clinical reasoning in encounters with virtual patients do not account for the nonlinear nature of the clinical reasoning process (Hege et al., 2017). However, we have recently developed a rubric, the virtual patient version of the Lasater Clinical Judgment Rubric (vpLCJR), that is based on the Lasater Clinical judgment rubric (LCJR) (Lasater, 2007). The vpLCJR is designed to assess nursing students' clinical reasoning processes when encountering virtual patients (Georg et al., 2018). This paper reports on the psychometric properties of the virtual patient version of the Lasater Clinical Judgment Rubric.

2. Background

2.1. Clinical reasoning

The term 'clinical reasoning' is used in this article to describe the logical strategies and cognitive processes that form the basis for how "nurses collect cues, process the information, come to an understanding of a patient's problem or situation, plan and implement interventions, evaluate outcomes, and reflect and learn from these processes'" (Levett-Jones et al., 2010, p. 516).

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2.2. Virtual patients

Virtual patients are screen-based interactive patient scenarios. In the virtual patient simulation, the learners emulate the role of healthcare providers and obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions (Ellaway et al., 2006). They are self-directive, problem oriented (Peddle et al., 2016), considered to be acceptable surrogates for real patient encounters and effective for training nurses in clinical reasoning (Fleiszer et al., 2017). The use of virtual patients can be motivated from different perspectives and it is likely that virtual patients in coming years will play an increasing role in medical education (Berman et al., 2016). Digital technology is growing and will be a part of our daily life. Technology is bringing many exciting opportunities for the health care sector and education, impacting what, where and how education is delivered and assessed. For this reason, supporting facilitators of education to make the most of new technologies is important. The interactivity of virtual patients has the potential to supply experiential learning by motivating learners to actively participate in the educational process (Cendan and Lok, 2012; Edelbring et al., 2011). Virtual patients are also believed to foster active learning (Consorti et al., 2012) and can provide opportunities for self-directed learning leading to reflection and self-driven change as well as self-knowledge regarding performance (Cendan and Lok, 2012). The full potential of virtual patients as a teaching and assessment strategy for learners' clinical reasoning abilities is, however, not yet fully understood (Cook et al., 2010; Ellaway and Davies, 2011). Although a number of studies do attest to the effectiveness of virtual patients in enhancing, fostering and assessing students' development of clinical reasoning, the results are inconclusive. One challenge is that evaluation is often outcome-oriented and does not account for the non-linear nature of the clinical reasoning process (Hege et al., 2017). Another challenge is that the outcome is often based on students' self-reports about their own clinical reasoning skills.

2.3. Rubrics

One solution to enhance the evaluation process of the students' performance is the use of rubrics (Isaacson and Stacy, 2009). A rubric is a measurement instrument for assessing students' performance on the basis of behavioral descriptions in relation to intended learning outcomes (Davis and Kimble, 2011). The use of rubrics is new in the setting of assessing learners' clinical reasoning processes in encounters with virtual patients; however, some studies describe rubrics to assess medical students' summary statements when encountering virtual patients (Fleiszer et al., 2017; Smith et al., 2016). The virtual patient version of the Lasater Clinical Judgment Rubric (vpLCJR) is designed to deconstruct different aspects of clinical reasoning in nursing and provide students and educators with a defined set of performance criteria and expectation of what the students should achieve during virtual patient activities. It is also intended to provide a structure which can help educators in making objective assessments and a language to facilitate feedback and feedforward to students (Georg et al., 2018). The vpLCJR is based on the Lasater Clinical Judgment Rubric (LCJR) (Lasater, 2007)- a validated rubric (Adamson et al., 2012; Ashcraft et al., 2013; Jensen, 2013; Kim et al., 2016; Kristiansen et al., 2015; Miraglia and Asselin, 2015; Shin et al., 2014; Victor-Chmil and Larew, 2013) that applies the conceptual framework of Tanner's Clinical Judgment Model “Thinking like a nurse” (Tanner, 2006). The LCJR has been used extensively for educational and research purposes and modified for different contexts, and different learning activities (Ashcraft et al., 2013; Kim et al., 2016; Kristiansen et al., 2015; Miraglia and Asselin, 2015; Román-Cereto et al., 2018; Shin et al., 2014; Shin et al., 2015; Vreugdenhil and Spek, 2018). To the best of our knowledge, the vpLCJR is the first attempt to create a rubric to objectively assess and evaluate nursing students' clinical reasoning processes and performance during virtual patient encounters. The validity and reliability of the vpLCJR has not yet been established. Hence, there is a need to investigate the psychometric properties of the vpLCJR.

2.4. Aim

The aim of the current study was to determine the psychometric properties of the virtual patient version of the Lasater Clinical Judgment Rubric (vpLCJR).

3. Method

This study is part of a larger project using nonexperimental explanatory sequential mixed method case study design (Creswell and Plano Clark, 2011), aiming to increase the understanding about how to use virtual patients for teaching, learning and assessing nursing students clinical reasoning skills. We have previously published a study on the development of a rubric, the “virtual patient version of the Lasater Clinical Judgment Rubric” (vpLCJR). The LCJR (Lasater, 2007) provided the basis for the development of this new rubric, which is constructed to assess nursing students' clinical reasoning processes when encountering virtual patients (Georg et al., 2018). The present study uses a nonexperimental design to examine the psychometric properties of the vpLCJR. Data from the use of two different virtual patient scenarios were included in the analysis. The analysis was conducted in two steps; first, deductive content analysis and then a statistical analysis using exploratory factor analysis (EFA) with categorical variables.

3.1. The rubric

The vpLCJR was used as the measurement instrument in this study. This rubric was designed to assess nursing students' clinical reasoning during encounters with virtual patients, according to Tanner's (2006) four phases of clinical reasoning/judgment: *noticing (N1–N3), interpreting (I1–I2), responding (R1-R4)* and *reflecting (Ref1-Ref2)*. Each phase 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 (see Table 1). The eleven dimensions are also delineated with development descriptors for four distinct developmental levels: beginning, developing, accomplished, and exemplary, with descriptive statements at each of the four levels. This means that the rubric consists of a total of 44 items, eleven dimensions and four development descriptors (Georg et al., 2018). For rating purposes, a four-item Likert scale ranging from 1 = beginning to four = exemplary was used (Lasater, 2007).

Table 1
Phases and dimensions of the virtual patient version of the Lasater Clinical Judgment Rubric.

Phases of clinical reasoning	Dimensions (= clinical performance indicators)	Code
Noticing	Focused observation	N1
	Recognizing deviations from expected patterns	N2
	Information seeking	N3
Interpreting	Prioritizing data	I1
	Making sense of data	I2
Responding	Documentation; initial patient status and nursing history	R1
	Identifying nursing diagnoses and desired patient outcomes	R2
	Well-planned intervention	R3
	Being skillful	R4
Reflecting	Evaluation/self-analysis	Ref 1
	Commitment to improvement	Ref 2

3.2. Simulation scenarios

Two virtual patient scenarios were developed, based on the intended learning outcomes of a course in the nursing program (Georg and Zary, 2014). The first illustrated the care needs of a woman in her 40s with a 6-month history of pain-related joint inflammation (rheumatoid arthritis). The second scenario illustrated the care needs of a man in his 70s with a history of diabetes mellitus type 2 and heart failure. According to the intended learning outcomes, the complexity of scenario two was higher than that of scenario one. The software used to create the scenarios were the Virtual Interactive Cases system (VIC) (Toronto General Hospital, 2017; Zhou et al., 2018) and the Web-SP system (Zary et al., 2006). Each student used either the VIC or Web-SP system to interact with and collect data from the virtual patient. The navigation in both systems was exploratory-semi-linear (Huwendiek et al., 2009).

3.3. Participants and setting

Participants were recruited from a bachelor's in nursing programme at a university located in Sweden. A convenience sample consisting of 130 s-year nursing students, enrolled in a course that included both theoretical and clinical aspects, was invited to take part in the study. Clinical reasoning using virtual patients was one learning activity in this course. There were 125 students participating in each scenario, resulting in a total of 250 valid cases.

3.4. Data collection

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 to answer questions (n = 15) in a tool designed to help the students enhance their nursing and clinical reasoning process e.g. “What outcomes do you have in mind given the diagnosis?” “Motivate why you consider these outcomes to be appropriate”.

The students completed scenario one at the beginning of the course and scenario two at the end of the course. Between scenarios one and two, the students fulfilled a six-week clinical training period, in a ward at a hospital.

3.5. Data analysis

3.5.1. Deductive content analysis

In order to become familiar with the data, each student's texts – created when answering questions during the encounter with the virtual patient – were read several times. After that, a qualitative deductive content analysis, as described by Elo and Kyngäs (2008), was conducted using the items in the virtual patient version of the LCJR as predefined coding categories and as a lens. The analysis of the students' texts was conducted by the first author and confirmed by one of the senior researchers. When the deductive analysis was completed, each student's performance was converted according to Lasater's (2007) description into a four-point Likert scale and the results were quantified (Krippendorff, 2013). The psychometric properties of this result were then further analysed.

3.5.2. Statistical analysis

Before the statistical analysis, the data entry for the 44 items was checked for error against the coded rubrics. Descriptive statistics, including means and standard deviations of the scores assigned to each of the two cases and in total, were calculated and the scores of the participants' performances were calculated at both individual and group levels. The Kaiser-Meyer-Olkin test, value of sampling adequacy and Bartlett's test of Sphericity were conducted to test factorability. A Shapiro-Wilk test was used to determine the null-hypothesis of this test: that the population is normally distributed. The psychometric properties of the virtual patient version of the LCJR were examined using exploratory factor analysis (EFA) (Flora and Flake, 2017). The discriminative ability of the rubric was examined using categorical variables. Principal axis factoring (PAF) with a promax rotation (Reio and Shuck, 2015) was used to help us understand latent structures and patterns of correlation among the individual attributes of the rubric. The internal consistency of the rubric was calculated using Cronbach's alpha (α) and using commonly accepted Cronbach's alpha levels to interpret the internal consistency reliability of the rubric ($\alpha < .70$ = unacceptable, $\alpha < 0.70 - < 0.80$ = acceptable, $\alpha \le 0.80 - < 0.90$ = good and $\alpha \ge 0.90$ = excellent) (DeVellis, 2012). Cronbach's alpha was calculated for the total scale and the four phases.

Statistical analyses were conducted using the Statistical Package for the Social Sciences (IBM SPSS version 24).

3.6. Ethical considerations

Ethical approval for the study was received from the Regional Ethical Review Board in Stockholm (Dnr, 2015/1894–31/5). The students were informed that participation in the study was voluntary and anonymous and that they were free to withdraw from the study at any time. Written informed consent was obtained from all study participants. Identifying information was removed from the data and replaced with numerical codes.

4. Results

4.1. Sample demographics

The age of the participants ranged between 20 and 53 years (mean age 23 years) and the gender distribution was 12.5% male and 87.5% female, which corresponds to the gender distribution in the overall study population (Statistics Sweden, 2010). Descriptive statistics, including means and standard deviations, were calculated for each scenario, in total, and for each of the 44 items in the vpLCJR (see Table 2). Evaluation of the students’ clinical reasoning profile showed that the score for scenario one ranged from 11 to 42 with a mean of 25.52 (SD = 7.25). In scenario two, the score ranged from 15 to 44 with a mean of 28.87 (SD = 6.38), in a possible range of 11–44 (11 – if all items were identified as beginning level and 44 – if all items were identified as exemplary level).

According to Lasater's instructions (Lasater, 2007; Victor-Chmil and Larew, 2013), the students were assigned to the four developmental levels according to their mean scores. This led to the following distribution: 0.4% (n = 1) of the students were rated as beginning (score 11), 24% (n = 60) were rated as developing (score 12–22), 54% (n = 135) as accomplished (score 23–33) and 21.4% (n = 54) as exemplary (score 34–44).

4.2. Factor structure

Prior to performing exploratory factor analysis (EFA), the suitability of the data for such an analysis was assessed and the data demonstrated factorability. The correlation matrix demonstrated numerous correlations of 0.40 and above. Pearson's correlation matrix is displayed in Table 3.

The Kaiser-Meyer-Olkin test showed 0.903 and according to Cerny and Kaiser (1977), a value of 0.7 or greater supports the use of factor analysis on the data and values between 0.9 and 1 indicate that the sample is fit for factor analysis. Bartlett's test of sphericity was significant ($\chi^2 = 222.64$, $df = 55$, $p < .001$), indicating factorability of the correlation matrix. The variables were normally distributed. Skewness was (-1 0 + 1). The normal-test shows an even distribution of the total sample.

The EFA suggested that the rubric consists of three factors rather

Table 2
Descriptive statistics; overview of means and std. deviation scores for the different items.

Code	Phases and dimensions of clinical reasoning	Mean case 1	Standard deviation	Mean case 2	Standard deviation	Mean Total	Standard. deviation
Noticing							
N1	Focused observation	2.52	.921	2.77	.798	2.65	.871
N2	Recognizing deviation from Expected patterns	2.31	.734	2.71	.758	2.52	.782
N3	Information seeking	2.44	.797	2.83	.679	2.63	.766
Interpreting							
I1	Prioritizing data	2.23	.763	2.60	.759	2.43	.795
I2	Making sense of data	2.27	.776	2.63	.753	2.47	.797
Responding							
R1	Documentation; initial patient status/nursing history	2.50	.819	2.99	.789	2.74	.840
R2	Identifying nursing diagnoses and desired patient outcomes	2.30	.951	2.46	.798	2.36	.878
R3	Well-planned intervention	2.06	.953	2.54	.776	2.29	.898
R4	Being skillful	2.15	.942	2.43	.773	2.28	.878
Reflecting							
Ref1	Evaluation/self-analysis	2.50	.904	2.80	.595	2.63	.789
Ref2	Commitment to improvement	2.26	.941	2.48	.841	2.36	.897

than the four proposed by Tanner's model (see Table 4). All 11 items loaded strongly (> 0.60) on one of the three factors and no item cross loaded.

The suggested factors, which were named: “Understanding the patient”, “Care planning” and “Reflecting” explained 81.8% of the variance (Fig. 1). The first factor, “Understanding the patient”, contained three items from the noticing phase, two items from the interpreting phase, and one item from the responding phase. Factor 1 explained 60.6% of the variance. The second factor, “Care planning”, contained the remaining three items from the responding phase, explaining 11.3% of the variance. The third factor, “Reflecting”, contained two items from the reflecting phase, explaining 9.8% of the variance.

4.3. Reliability analysis

As a measure of reliability, Cronbach's alpha was used, showing 0.931 for all items, indicating consistent reliability. The subdomain with the highest Cronbach's alpha was “Responding” (α = 0.912), followed by “Noticing” (α = 0.907), “Interpreting” (α = 0.860), and “Reflecting” (α = 0.838). The analyses of the Cronbach's alpha values for each item are presented in Table 5.

5. Discussion

This study focused on determining the factor structure of the virtual patient version of the Lasater Clinical Judgment Rubric (vpLCJR), in

Table 4
Exploratory factor analysis.

Code	Phases and dimensions of clinical reasoning	Factor 1 *Understanding the patient*	Factor 2 *Care planning*	Factor 3 *Reflecting*
Noticing				
N1	Focused observation	**.835**	.213	.202
N2	Recognizing deviation from Expected patterns	**.855**	.266	.140
N3	Information seeking	**.822**	.304	.224
Interpreting				
I1	Prioritizing data	**.858**	.256	.158
I2	Making sense of data	**.737**	.377	.134
Responding				
R1	Documentation; initial patient status/nursing history	**.642**	.485	.164
R2	Identifying nursing diagnoses and desired patient outcomes	.284	**.851**	.178
R3	Well-planned intervention	.335	**.861**	.173
R4	Being skillful	.369	**.862**	.187
Reflecting				
Ref1	Evaluation/self-analysis	.248	.198	**.869**
Ref2	Commitment to improvement	.155	.164	**.908**

Extraction method: Principal competent Analysis.
Rotation Method: Varimax with Kaiser Normalization, rotation converged in 5 iterations.

Table 3
A Pearson's correlation matrix.

Phases and dimensions	N1	N 2	N3	I1	I2	R1	R2	R3	R4	Ref 1	Ref 2
N1 Focused observation	1	.715	.831	.746	.608	.625	.455	.512	.542	.406	.344
N2 Recognizing deviation from expected patterns	.715	1	.763	.800	.751	.668	.507	.526	.574	.406	.299
N3 Information seeking	.831	.763	1	.763	.680	.652	.528	.584	.611	.436	.382
I1 Prioritizing data	.746	.800	.763	1	.754	.654	.493	.526	.578	.413	.308
I2 Making sense of data	.608	.751	.680	.754	1	.637	.517	.581	.600	.357	.329
R1 Documentation; initial patient status/nursing history	.624	.668	.652	.654	.637	1	.590	.631	.652	.423	.320
R2 Identifying nursing diagnoses and desired patient outcomes	.455	.507	.528	.493	.517	.590	1	.760	.831	391	.341
R3 Well-planned intervention	.512	.526	.584	.526	.581	.631	.760	1	.887	.397	.355
R4 Being skillful	.524	.574	.611	.578	.600	.652	.831	.887	1	.449	.358
Ref1 Evaluation/self-analysis	.406	.406	.436	.413	.357	.423	.391	.397	.449	1	.727
Ref 2 Commitment to Improvement	.344	.299	.382	.308	.329	.320	.341	.355	.358	.727	1

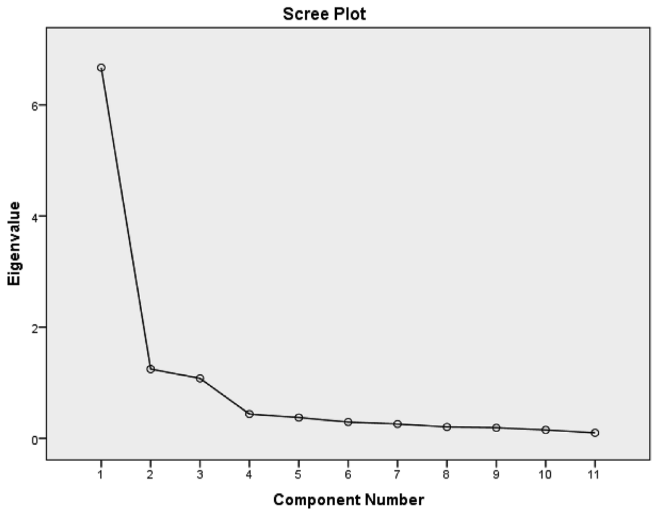

Fig. 1. Scree plot of the factor loading.

Table 5
Cronbach's alpha (α) for each item and in total.

Phases of Clinical reasoning	Dimensions of clinical reasoning	α
Noticing		.907
	Focused observation	.923
	Recognizing deviation from expected patterns	.923
	Information seeking	.921
Interpreting		**.860**
	Prioritizing 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**

order to provide empirical evidence for the rubric's usefulness in evaluating nursing students' clinical reasoning when working with virtual patients. The vpLCJR was developed in response to difficulties in assessing and objectively evaluating cognitive and affective aspects of nursing students' clinical reasoning during encounters with virtual patients. The vpLCJR was also developed in response to an identified need to facilitate communication about clinical reasoning by introducing a standardised language (Georg et al., 2018). Clinical reasoning is often assessed using global rating, but a disadvantage of such approaches is that global rating often does not provide feedback to learners that can guide improvement (Smith et al., 2016). The use of rubrics has the potential to transform the often-subjective global rating assessment into a more objective evaluation (Fleiszer et al., 2017), and can foster rapid review and facilitate proper feedback to learners. It has been shown (Dickinson and Adams, 2017) that the use of rubrics can help learners to understand what is expected of them and thereby promote learning. It has also been shown that the use of rubrics can promote continuity and consistency among teachers (Dickinson and Adams, 2017). Previous studies have stated that the LCJR is a validated evidence-based clinical judgment rubric that has the capacity to in a structured manner support nursing student to develop clinical reasoning skills. It has also been shown to formatively evaluate nursing students clinical reasoning in the context of high fidelity simulation using human-like manikins (Lasater, 2011). The new rubric, the vpLCJR, is based on LCJR and consists of a set of explicit descriptors of various aspects of clinical reasoning that provide a defined set of performance criteria and expectations of what students should achieve which may be useful for both learners and clinical educators. The rubric may facilitate an objective assessment of students' clinical reasoning skills and provides a language to facilitate feedback and feedforward to the students (Georg et al., 2018).

In order to determine the factor structure of the vpLCJR, we performed an exploratory factor analysis (EFA) with categorical variables. Exploratory factor analysis serves different purposes in research (Flora and Flake, 2017). One common purpose is to reduce relatively large sets of items or variables into more manageable ones; another purpose can be to explore relations among variables in order to contribute to theory. Hence, as all the items in the rubric are based on Tanner's model and Cronbach's alpha values were high, we did not consider removing items. The findings from the EFA in this study did indicate, however, that the original four phases (noticing, interpreting, responding and reflecting) found by Tanner (2006) could be reduced to three phases in the context of virtual patient simulation. The three factors that were revealed in the EFA, "Understanding the patient", "Care planning" and "Reflecting" are related to the Outcome-present state test (OPT) model of clinical reasoning. The OPT model builds on the heritage of the traditional nursing process and at the same time differs from it in several important ways. The OPT model provides a structure for iterative clinical reasoning by focusing on organising patients' needs and nursing care activities around keystone issues and outcome specifications (Kautz et al., 2005; Kuiper et al., 2017; Pesut and Herman, 1999, 1998).

The first factor, "*Understanding the patient*", consists of items from the noticing phase and the interpreting phase, along with one item from the responding phase, items relating to knowing the patient. It includes how the nursing student filters, frames and focuses on data in order to grasp the situation at hand, develop a sufficient understanding of the patient's situation and communicate this understanding in a summary statement.

The second factor, "*Care planning*", is related to how the students respond to the needs of the patient. It demonstrates their ability to embrace the patient's story and identify the patient's problems and needs with a specific outcome and plan for nursing interventions. In this factor, the students' ability to create written care plans and use nursing terminology is also included.

The third factor, "Reflecting", contained the two original reflecting items. This factor reflects both reflection in and reflection on action. While reflection in action refers to the student's ability to read the patient and respond to their needs, reflection on action is more about the subsequent learning cycle and what the student has learned from the experience (Schön, 1983; Tanner, 2006). Together, these aspects comprise a significant component of nursing students' development of clinical reasoning.

Together, these three factors explained 81.8% of the variance. The new three-factor structure of the 44-item vpLCJR seems to reflect the clinical reasoning competence required for nursing undergraduate students. The factors also allow educators to understand the students' levels of knowledge and competence regarding clinical reasoning in nursing.

The Cronbach's alpha value of 0.931 indicates that all items are interrelated, contribute to a single construct and that the rubric is internally consistent. This is consistent with findings from testing of the internal consistency of the LCJR, which showed high levels of Cronbach's alpha (Kim et al., 2016; Román-Cereto et al., 2018; Victor-Chmil and Larew, 2013; Vreugdenhil and Spek, 2018).

The results also showed that the students' results were distributed across all development descriptors (beginning, developing, accomplished and exemplary) in the rubric. This indicates that the different dimensions and development descriptors of the vpLCJR have the ability to capture all the different aspects of clinical reasoning and that it is feasible to use the rubric. The results also showed that it was 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' development of clinical reasoning during their encounters with virtual patients.

When comparing the results for the two cases, it could be seen that the sum scores were higher for virtual patient case two. The mean sum score in case one was 25.52, and for case two it was 28.87, even though the complexity was higher for case two. One explanation could be that the students completed scenario two after they had fulfilled a six-week training period in a ward at the hospital and had completed different theoretical assignments regarding clinical reasoning in nursing. This may indicate that students need learning activities that assist them in transferring their theoretical knowledge into clinical practice. This is consistent with current literature (Benner et al., 2010; Jessee and Tanner, 2016) stating that clinical reasoning is best learned through multiple learning experiences involving patient encounters (both real and in simulations). The difference in sum scores also indicate that it is feasible to use the vpLCJR for assessing students' learning outcomes and progress in clinical reasoning using virtual patients.

6. Limitations

One limitation possibly affecting the generalisability of our study is that the number of students who participated in this study can be considered low. Research remains unclear about the ideal sample size for exploratory factor analysis but according to Comrey and Lee (2013) a sample size of 200 can be seen as fair.

Since all but five participants were included in this study, the sample size of 250 could be considered enough. However, more analyses with larger samples would be beneficial in the future. Another possible limitation could be that all students came from the same university which may have caused a selection bias. It is possible that the students in this university have good knowledge of digitalisation and virtual patient, since the development in the field is progressing rapidly, and today most students are familiar with the concept. In order to confirm the rubric's utility for research and practice, we recommend further testing with participants from other educational contexts and levels. The inter-rater reliability was not assessed in this study, but two different researchers rated the data separately and reached the same result. Future studies with multiple virtual cases and raters would strengthen the rigour of the instrument. In order to have harmony on taxonomy, terminology, and definitions of the properties included in this study the COSMIN checklist could have been an option used in the preparation of data (Mokkink et al., 2010; Prinsen et al., 2018). However, the COSMIN was initially developed to be used in Patient-Reported Outcomes (PRO), the checklist may be applicable in our settings of students as well.

7. Conclusion

This study has shown that the vpLCJR rubric can be used to assess nursing students' clinical reasoning processes during virtual patient simulations. The rubric provides clinical educators with a standardised measurement instrument to elucidate and objectively assess different aspects of students' clinical reasoning processes. Virtual patient simulation creates a safe learning environment that can easily be altered to meet the students' actual knowledge and capacity levels. The results of this study indicate that the vpLCJR is both valid and reliable. The rubric has the potential to be used as a valid assessment instrument to objectively assess nursing students' clinical reasoning when encountering virtual patients. Furthermore, the results indicate that, with the rubric, it is possible to assess both the level and the progress of students' clinical reasoning.

Conflicts of interest

We wish to confirm that there are no known conflicts of interest associated with this publication.

Ethical approval details

Ethical approval for the study was received from the Regional Ethical Review Board in Stockholm (Dnr, 2015/1894–31/5).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nepr.2019.05.016.

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