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Featured Article

Transformative Learning through Virtual Patient Simulations: Predicting Critical Student Reflections

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Abstract

Background: The Digital Clinical Experience™ is a simulation software that allows nursing students to interview and examine virtual patient and then write self-reflections on their performance.

Methods: A secondary data analysis was conducted on 130 master of science in nursing students' performance in the Digital Clinical Experience™ using a framework of situated cognition and transformative learning theory. Employing a within-stage mixed-model design, content analysis of structured self-reflections was conducted using Cook's Reflection Rating Rubric. Multiple regression was performed using self-reflection scores as the dependent variable; independent variables included time spent in simulation, lines of dialog, and primary and secondary clinical items discovered.

Results: Critical self-reflection indicating transformative learning was predicted by the number of secondary clinical items students uncover during their virtual patient interview. Yet, this level of self-reflection did not occur for students who discovered only the primary clinical findings.

Conclusions: This study presents evidence that virtual patient simulations can provide transformative learning experiences in nursing. However, to facilitate a transformative learning experience, these simulations must allow students to explore the presentation, history, and backstory of the virtual patient in depth, beyond superficial clinical findings.

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Self-reflection by students is a critical component to learning complex and multifaceted content, and is especially important in the development and assessment of clinical reasoning skills (Anderson, 2010; Langley & Brown, 2010; Lasater & Nielsen, 2009; Mezirow, 1990; Plack, Driscoll, Blissett, McKenna, & Plack, 2005). The Shadow Health Digital Clinical Experience™ (DCE) is a web-based virtual

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patient simulation that affords nursing students the opportunity to interview, examine, document, and reflect on their experience with the Shadow Health Digital Standardized Patient™. The DCE is divided into a series of longitudinal modules, which correspond to the different components of a health assessment, including taking a health history and system-based examinations. The DCE was used for the first time in Advanced Health Assessment courses by master of science in nursing (MSN) students at six universities in the United States during the fall semester of 2012. Although the software automatically generated and displayed quantitative assessment data on the clinical findings discovered by students after they interview and examine Digital Standardized Patient (DSP), there has been no systematic evaluation of the reflective journaling that students complete as part of each assigned module. To assess the quality of the reflections written within the DCE and explore which variables may influence successful, critical levels of reflection, this exploratory study evaluated students' self-reflections using the coding rubric developed by Cook (2010) (see Table 1). This study employed an ex post facto research design to explore the following questions: (1) Is the quality of student reflections related to success within the History module of the DCE? (a) Is there a relationship between student reflection scores and the number of clinical findings discovered? (b) Is there a relationship between student reflection scores and the time a student spends asking the DSP questions? and (c) Is there a relationship between student reflection scores and the number of questions a student asks the DSP?

Key Points

- A student's performance within their Digital Standardized Patient simulation predicted the quality of the self-reflection they wrote after the experience.
- More thorough exploration of secondary clinical findings was positively correlated to critical levels of self-reflection, whereas patient interviews that focused only on primary clinical findings were negatively correlated to the level of self-reflection.
- To facilitate effective simulations for the purpose of transformative learning experiences, virtual patients should provide a broad range of findings for students to explore.

Literature Review

Virtual patients have been found to be a dynamic and cost-effective means of providing nursing students with standardized clinical simulations (Consorti, Mancuso, Nocioni, & Piccolo, 2012; Cook & Triola, 2009; Cook, Erwin, & Triola, 2010). Virtual patients create an objective learning environment by presenting each student with an identical simulation scenario. Virtual patients provide students with a more uniform opportunity to assess their skills than standardized patient actors, who can insert biases or become bored with the repetition of performing the same simulation repeatedly with multiple students (Consorti et al., 2012; Cook & Triola, 2009; Johnsen et al., 2005). Another advantage of virtual patients is a more convenient simulation experience that can often be accessed asynchronously, which makes them ideal for distance education programs. Virtual patients are relatively new in the field of clinical simulations; however, their low cost in comparison with simulations using high-fidelity manikins or patient actors makes them appealing in the field of nursing education, where budgets are typically tight, and there is a shortage of educators (Cook & Triola, 2009; Cook, 2010). Studies conducted on virtual patients thus far have included qualitative, quasi-experimental controlled, and comparative designs, all of which found no significant difference between learning outcomes and learner satisfaction when compared with other methods of simulation (Consorti et al., 2012; Cook, Erwin, & Triola, 2010; Triola et al., 2006). Additionally, virtual patient simulations have been shown to yield large positive effect sizes when compared with no simulation (Cook, Erwin, & Triola, 2010).

The use of virtual patients in health professions education has been applied to a wide range of clinical fields (Arnold, Johnson, Tucker, Chesak, & Dierkhising, 2013; Forsberg, Georg, Ziegert, & Fors, 2011; McKeon, Norris, Cardell, & Britt, 2009; Stevens et al., 2006). Although, in most cases, the learning objectives of virtual patient simulations include the development or assessment of clinical reasoning skills, Cook and Triola (2009) have made the argument that demonstrating clinical reasoning is the only valid learning objective for a virtual patient simulation. Cook and Triola, base their assertion on the observation that analytical thinking will mature an individual health care provider's practice and lead to safer, more effective patient care decisions. Although virtual patients are uniquely suited to develop clinical reasoning, the assessment of virtual patients most often employs an algorithmic approach to evaluation, scoring the completeness of information elicited by the student rather than evaluating nonanalytical processes (Cook & Triola, 2009).

Reflective journaling is another common strategy employed in the development of students' clinical reasoning skills (Anderson, 2010; Hendrix, O'Malley, Sullivan, & Carmon, 2012; Lasater & Nielsen, 2009). Self-reflections written as part of clinical rotations and simulation assignments have been well established as a successful activity through which nursing students can further their diagnostic abilities, strengthen their patient empathy skills, challenge assumptions and biases, and self-correct areas of weakness (Langley & Brown, 2010; Lasater & Nielsen, 2009;

Table 1 The Rubric Used to Rate Students' Reflections. The Coding Instrument was Developed to Assess the Level of Reflective Journaling by Cook (2010)

Reflection Rating Rubric			
Score	1	2	3
Classification	Nonreflection No evidence of reflection is present.	Reflection Evidence of reflection is present.	Critical Reflection Evidence of critical reflection is present.
Criteria	The reflection describes experiences, but does not analyze, question, or evaluate the actions described.	The writer offers more than just descriptions, and attempts to analyze, evaluate, or question the situation or events.	The writer critically explores challenges, failings, or problems, why they occurred, and how they may address them. Recognizes and addresses own assumptions or biases.

Mezirow, 1990; Plack et al., 2005). Because reflective journaling facilitates students' critical self-assessment, in partnership, virtual patient simulations and self-reflections have the potential to provide an accessible and introspective learning experience for nursing students in the development of clinical reasoning skills.

Conceptual Framework

The theoretical orientation of this study relies on both situated cognition and transformative learning theory, under the constructivist paradigm (Duffy & Jonassen, 1992). This theoretical framework served as the lens through which student success was gauged, as they acquired contextual knowledge and worked to increase the effectiveness of their performance and the development of their clinical reasoning abilities (Figure 1).

Situated cognition suggests that knowledge cannot be separated from context (Brown, Collins, & Duguid, 1989), which aligns with the use of the DSP in educating graduate nursing students on the clinical, empathy, and communication skills required to conduct patient examinations. Likewise, a more relevant context for the knowledge during the learning process will facilitate a more flexible and adaptable understanding for the learner. Structured self-reflections prompted immediately after students exited the simulation served to construct additional knowledge as the students were directed to consider other contexts in which to apply their newly acquired experience.

Transformative learning is a process of challenging established biases, assumptions, and behaviors (Mezirow, 1990); a concept that illustrates the objectives of the reflective journaling activities within the virtual patient software. Transformative learning is a crucial component to the self-reflection process of adult learners in particular, as this population must critically reassess what is often well-established knowledge constructed through prior experience in relation to new, sometimes contradictory information and events (Mezirow, 1997). Through the construction of knowledge within the context of a digital clinical simulation, MSN students had the opportunity to challenge their own assumptions and biases in light of their discoveries and performance, which could then be developed and articulated within the self-reflections.

Method

Participants

The participants in this study were MSN students attending one of six institutions located across the United States. Of the entire population of 177 students with active Shadow Health accounts during the fall 2012 semester, 130 completed the first clinical module of the DCE, in which

Table 2 The Regression Model with Implications for Practice as the Outcome Variable

	Unstandardized Coefficients		Standardized Coefficients	
Predictor Variables	B	Standard Error	β	Significance (*p*)
Constant	2.157	0.257		0
Lines of dialog count	−0.002	0.001	−0.609	.056
Number of minutes	0.002	0.003	0.155	.513
Red Flags found	−0.111	0.050	−0.352	.031
Critical Items found	0.59	0.018	0.903	.001

Note. $R^2 = 0.109$.

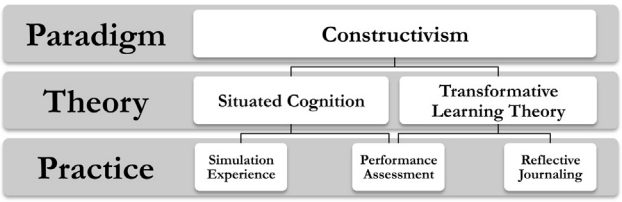

Figure 1 Conceptual framework diagram.

a patient history is taken, as partial fulfillment of the requirements of their respective health assessment courses. The proprietary data collected included all existing History modules (Module 1) submitted for instructor review. To ensure anonymity, identifying information, including demographics, was not recorded. An institutional review board protocol was submitted to the University of Florida for this study and was found to be exempt due to the secondary data analysis performed; no informed consent was required (Parry & Mauthner, 2004).

Materials

The Shadow Health DCE for graduate nursing students consists of 10 modules. Apart from the initial orientation module and the final assessment module, each module involves a clinical simulation with the DSP, during which students can pose questions, direct the patient's actions, and make empathetic or educational statements to the patient through typed speech (Figure 2). The DSP responds to students with both audio and text. Within the simulated clinical setting, students can also use virtual instruments and tools to conduct a full physical examination. The clinical modules are divided into topics to facilitate integration into a health assessment course: taking a patient history; head, ears, eyes, nose, and throat; respiratory; cardiovascular; gastrointestinal; musculoskeletal; neurological; and psychological.

On completion of the clinical portion of each module, students are presented with a Self-Reflection page. On the Self-Reflection page, students are able to view the focus note they wrote during their clinical interaction and compare their documentation with a model focus note written and validated by nursing practitioners and educators. Beneath the student and model focus notes, there is a three-tabbed open text field within which students are directed to write three structured reflections. The three reflection tabs are titled: Descriptive, Clinical Reasoning, and Implications for Practice. The prompts are as: (a) Descriptive: Explicitly describe the tasks undertaken to complete each examination within the module, (b) Clinical Reasoning: Explain the clinical reasoning behind your tasks and judgments, and (c) Implications for Practice: Document how your performance could be improved and how you would apply "lessons learned" within the module to your professional nursing practice.

After writing their self-reflections, students may view their Results page before submitting the module to their instructor for assessment. The Results page presents students with two categories of clinical findings, and marks each item as either found or missed, based on what information the student elicited from the DSP during the interview and/or examination in that module (Figure 3). The most medically relevant findings are "Red Flag" findings. Without discovering all the 11 primary Red Flag findings in the History module, the student could not properly treat the patient. The remaining findings in the scoring rubric are organized by topic and categorized as "Critical Item" findings. These 64 secondary findings are relevant to the treatment of the patient but are not imperative to treat her chief complaint or other most pressing current medical issues.

Figure 2 The Digital Standardized Patient, Tina Jones, and her mother, Denise, in the Digital Clinical Experience examination room.

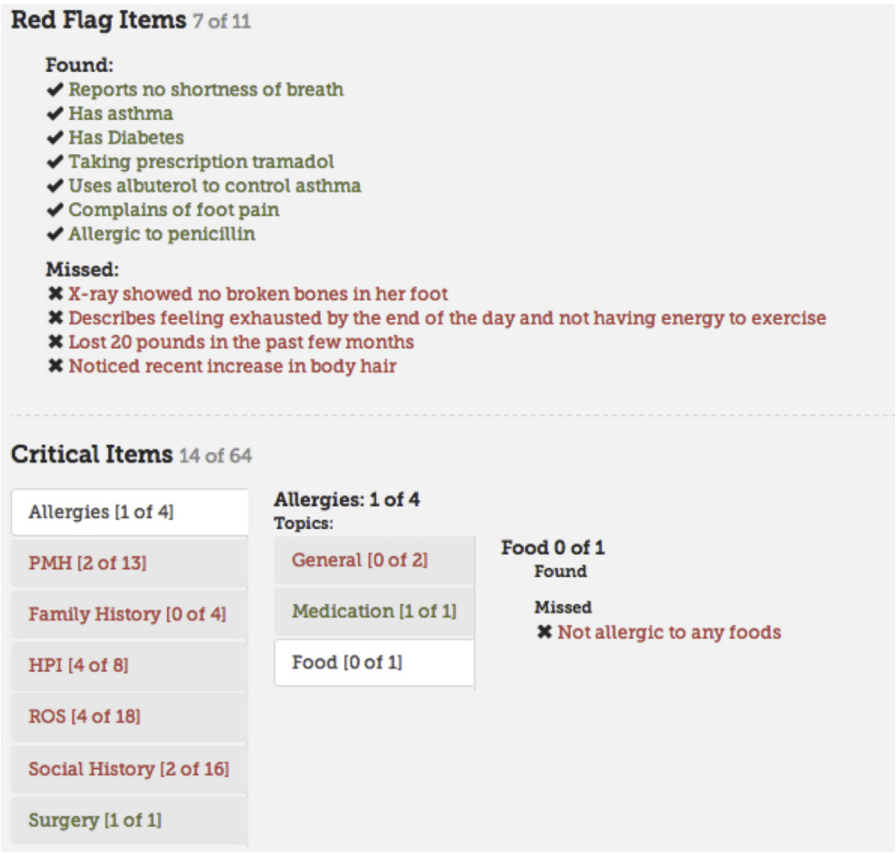

Figure 3 A sample Results page from the Digital Clinical Experience, displaying Red Flag and Critical Items

For this exploratory study, only the Clinical Reasoning and Implications for Practice reflections from the first History module were evaluated. As evidenced by the instructions provided, the Descriptive reflection was designed to serve as a device to elicit recall of the clinical experience to facilitate more meaningful reflections on the Clinical Reasoning and Implications for Practice prompts. The History module was chosen for this study because it is the most conversation-intensive module and presents more variability in the findings that students may discover owing to the depth and breadth of the DSPs character and script.

Instrumentation

Self-reflection entries were coded using the Reflection Rating Rubric developed by Cook (2010) (Table 1). Cook's instrument was developed using criteria identified by Mezirow (1990) and following procedures based on the process used by Plack et al. (2005). The interrater reliability reported for Cook's pilot study, in which three physical therapy clinicians and the author were trained and then scored five selected journals, was $r = 0.823$. After discussing the five scored journals, a second set of five journals was selected and scored, for which interrater reliability was reported as $r = 0.940$, which is more than adequate to establish consensus. Using Cook's instrument, each Clinical Reasoning and Implications for Practice reflection submitted to an instructor for review through the DCE was coded as 1 for a nonreflection, 2 for a reflection, and 3 for a critical reflection.

Scoring and Data Analysis

The data included in this study employed both quantitative and qualitative elements in a within-stage mixed-model design (Johnson & Onwuegbuzie, 2004). Scoring of the Clinical Reasoning and Implications for Practice reflection entries submitted for the History module by MSN students during the fall semester of 2012 generated quantitative data for analysis.

The reviewers were trained by the author on using the Reflection Rating Rubric (Cook, 2010) and then coached on how to apply the rubric to the self-reflections submitted in the History module of the DCE. The reviewers included the author, an instructional designer, and the director of script development, all of whom were employed at Shadow Health during the evaluation process. After coding one sample Clinical Reasoning reflection and one sample Implications for Practice reflection as a group using the Reflection Rating Rubric, the three reviewers each coded the same five Clinical Reasoning reflections and the same

five Implications for Practice reflections. Interrater reliability on the first round of reflections was not optimal ($r = .60$). After discussing the scores each reviewer gave the reflections and negotiating a deeper understanding of the rubric, a second set of five Clinical Reasoning reflections and five Implications for Practice reflections were scored. Interrater reliability for the second round of reflections was adequate ($r = 0.70$) (Multon, 2010). After interrater reliability was established, the remaining 239 Clinical Reasoning and Implications for Practice reflections were divided into three groups for individual coding by the three reviewers.

The data for this study, including the self-reflections, number of Red Flag findings discovered, number of Critical Items discovered, time spent, and number of transcript lines, were exported directly from the DCE software. Linear models of multiple regression were used to explore the relationships within the data. After scoring the self-reflections, the two models examined included: (a) Clinical Reasoning reflection score as the outcome variable and the number of Red Flag items discovered, the number of Critical Items discovered, the number of transcript lines, and the number of minutes spent in the clinical portion of the module as the predictor variables, and (b) Implications for Practice reflection score as the outcome variable and the number of Red Flag items discovered, the number of Critical Items discovered, the number of transcript lines, and the number of minutes spent in the clinical portion of the module as the predictor variables.

Results

Multiple regression analysis was conducted to determine whether the four independent variables (lines of dialog count, minutes spent with the DSP, Critical Items discovered, and Red Flag items discovered) are significant predictors of Implications for Practice or Clinical Reasoning reflection scores. As predicted, the lines of dialog and minutes spent were significant predictors of Critical Items and Red Flag items discovered.

The overall regression model with Implications for Practice as the outcome variable was significant ($t = 8.377$ and $p < .001$) (Table 2). Collinearity was not present, the cross validity of the model was adequate, and the distribution of the variables was linear. The model's adjusted R^2 (0.109) indicated that the variables explained approximately 10% of the variance. The most significant predictor of the Implications for Practice reflection score was Critical Items discovered ($\beta = 0.903$ and $p < .001$). Another significant predictor, although negatively correlated, was of the level of Implications for Practice reflection was Red Flag items ($\beta = -0.352$ and $p = .031$). Lines of dialog count approached significance ($p = .056$).

A multiple regression model with the same predictor variables and Clinical Reasoning reflection score as the outcome variable approached significance ($p = .064$). The only significant predictor was minutes spent ($\beta = 0.706$ and $p = .004$).

Discussion

The results of this study indicate that the number of Critical Items discovered had a strong positive correlation with the Implications for Practice reflection score. This suggests that as students explored the secondary clinical findings more thoroughly, they reflected more critically on the application of the experience to other contexts outside the DCE. Conversely, the number of Red Flag findings discovered was negatively correlated to the level of Implications for Practice reflection. This finding must be interpreted within the context of the positive correlation between the Red Flag and Critical Item findings. The Red Flag findings are essential information and are easily uncovered by the most MSN students. However, Critical Item findings can only be discovered by asking thoughtful follow-up questions based on the DSPs responses. Because the DCE findings are classified in this way, a student could discover most or even all the Red Flag findings through narrowly focused questions without discovering secondary, Critical Items. In turn, it is improbable that a student could discover a significant number of Critical Items without also uncovering the primary Red Flag findings. These relationships imply that students who discovered only the more straightforward and medically significant Red Flag findings were less likely to reflect critically on the implications of the experience for their practice, and that broader investigation into the DSPs history facilitated a more critical self-reflection in which students were able to apply their simulation experience to other contexts. These findings also suggest that a patient interview that was narrower in scope was not sufficient to foster transformative learning.

These results are consistent with the conceptual framework of this study. Transformative learning occurred as students explored more topics, using focused follow-up questions, and then reconciled the wide range of findings discovered. In this way, students challenged their prior knowledge and assumptions in light of a deeper and more meaningful experience. Students constructed contextual knowledge that was more adaptable to external contexts as they spent more time and typed more lines of dialog within the DCE, which then facilitated a more critical level of reflection on the application of their new knowledge to their professional practice.

Because of the proprietary nature of the data collected and the unique technology that is employed within the simulation software, generalizability of these results is limited and may not apply directly to every context out of the scope of the Shadow Health DCE. Generalizability is also limited to the population of MSN students. Delimitations of this study include the restriction of data analyzed to the first clinical module, in which students take a patient history. Results could potentially vary in future study of the remaining system-based modules where there is less subjective data to gather from the DSP. Demographic data were also limited, as age, gender, years of experience, and

salary were not available in the software and could not be analyzed in this study.

The implications of these findings affect both the DCE itself, as well as other simulation technologies. To accomplish effective, situated cognition in the pursuit of a transformative learning experience, virtual patient simulations should include sufficient depth and breadth to facilitate exploration not just of primary clinical findings, but also of findings that address the holistic nature of the patient character. Although this level of detail and depth of conversation may prove challenging within some applications, if the learning objective is to achieve a critical level of self-reflection, it is not sufficient to present superficial case studies and one-dimensional virtual patients to nursing students.

Transformative learning through self-reflections on simulations is a potentially fruitful area of research. This study should be replicated with the Shadow Health DSP designed for undergraduate nursing students to evaluate if the findings of this study can be generalized to entry-level learners. Future studies should explore the nature of self-reflections written within the other system-based modules of the DCE as well as other, similar learning environments. Researchers should also analyze the quality and depth of self-reflections within virtual patient simulations compared with those following high-fidelity simulations.

Conclusion

This study illustrates the importance of designing meaningful contextual simulations and self-reflection activities for graduate nursing students. Faculty are increasingly in need of flexible methods to deliver instruction and provide students with access to clinical experiences. Virtual patients can offer a cost-effective and convenient solution. However, as virtual patient simulations are being employed more frequently, these experiences should be constructed to support the development of clinical reasoning in ways that are adaptable to a variety of contexts. When students self-reflect on simulated clinical experiences, they apply their new, flexible knowledge to transformative learning opportunities that allow them to challenge established assumptions and biases. Complex virtual patient simulations, in conjunction with self-reflection activities, can engage students in significant transformative learning that develops insightful, knowledgeable nurses.

Conflict of interest

We acknowledge the following potential conflict of interest; The author of this manuscript was at the time of its creation and is currently employed at Shadow Health, the creator of the Digital Clinical Experience. The content analysis performed in the collection of data was conducted by the author, as well as two additional employees of Shadow Health. The author of this manuscript collected, analyzed, and interpreted the data, as well as wrote and submitted the manuscript.

No funding was provided by Shadow Health for this study. No grants or scholarships were provided to any students using the DCE. All system data was collected after the semester in which students used the DCE. Students accessed the DCE either through their school of nursing, or through direct purchase of a license on the Shadow Health website.

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