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Featured Article

Clinical Virtual Simulation in Nursing Education

José Miguel Padilha, RN, MScN, PhD[a,b,*], Paulo Puga Machado, RN, MScN, PhD[b], Ana Leonor Ribeiro, RN, MScN, PhD[b], José Luís Ramos, RN, MScN[b]

[a]*CINTESIS—NurseID-ESEP, Center for Health Technology and Services Research, Porto, Portugal*
[b]*Nursing School of Porto, Porto, Portugal*

KEYWORDS
immersive;
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Abstract

Background: The introduction of simulation has produced significant improvements in nursing education. The technological evolution gives way to new opportunities through new pedagogical strategies. Some limitations found in high-fidelity simulators can be overcome by clinical virtual simulation (CVS). However, little is known about students' perceived ease, usefulness, and intention to use this new pedagogical strategy applied to nursing education. The aim of this study is to assess the ease, usefulness, and intention of pregraduate nursing students to use a clinical virtual simulator.

Method: An exploratory, descriptive, and cross-sectional study was conducted using a quantitative approach. A nonprobabilistic sample of 426 pregraduate students was recruited from a Portuguese nursing school. The data were collected through a questionnaire (10-point Likert scale) based on the Technology Acceptance Model.

Results: The results showed an average of perceived ease to use the simulator of 8.99 ($SD \pm 1$) and a perceived usefulness and intention of 9.60 ($SD \pm 0.55$) to use the clinical virtual simulator in pregraduate nursing education. Results also showed an average of 9.55 ($SD \pm 0.73$) for relevance and an average of 9.71 points ($SD \pm 0.59$) for the facilitator role of CVS in nursing education.

Conclusion(s): The pregraduate nursing students revealed perceived ease, usefulness, and intention to use CVS as an important complementary strategy for their nursing education programmes.

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The rapid technological development has highly impacted nursing education with an emerging paradigm shift in the perceptions of students and teachers. For nursing students and teachers, the use of information and communication technologies (ICTs) has become a daily life activity.

The ease and usefulness of the use of technologies influence the education paradigm and encourage nursing professors to adopt constructive approaches in nursing education, with the nursing professor playing the role of a learning facilitator rather than a simple "lecturer."

Currently, many pregraduate nursing students are living in a new technological era, in which high-technology innovation is a demand and reality. Teachers are aware of this new emerging trend and are strongly committed to introducing state-of-the-art technological tools into nursing education. ICT educational tools' accessibility and usability have changed the way students face learning processes and

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* Corresponding author: miguelpadilha@esenf.pt (J. M. Padilha).

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have challenged and motivated them to actively engage in education. Prensky (2001a,2001b) pioneered the discussion about learning differences between digital native and digital immigrant, and this subject has raised the consensus or opposition of several authors (Koutropoulos, 2011). However, rather than emphasizing differences between groups or technological skills, the emphasis must be placed on technology capable of providing nursing students with user-friendly educational materials, aligned with the course/programme objectives.

Key Points

- Data show students' perceived ease in the use of clinical virtual simulation (CVS) in nursing education.
- Data show students' perceived usefulness in the use of CVS in nursing education.
- Students show intention to the use CVS in nursing education.
- Nursing students consider the clinical virtual simulator an important tool for their nursing education.
- Nursing students consider that the clinical virtual simulator acts a facilitator of their nursing education.

Nursing education has adopted educational strategies based on the theory of constructivism (Heimann et al., 2013). This theory advocates that knowledge is the product of the interaction between the individual and the environment and focuses on students as active learners, capable of attributing individual meanings to their personal experiences and building their own knowledge over time.

The discussion of the exposure to clinical experiences underlies the development of nurses' professional performance from novice to experts, an idea beginning in 1984 with Benner's writings (Benner, 1984). Benner's theories support our assumption that providing students with learning opportunities and confronting them with different virtual clinical scenarios, closely monitored by nursing teachers to help reflection in and on action, may likely enhance the development of clinical reasoning skills prior to the contact with a real patient. This strategy may function as a knowledge accelerator and most importantly contribute to future nursing practice based on safer and higher quality standards.

Simulation technologies adapted to nursing education were first introduced in the 1950s, with low-fidelity models gradually evolving to modern high-fidelity tools. Since then, these innovative technologies have been massively adopted to support knowledge acquisition and technical skills development. Notwithstanding, we are still facing difficulties to recreate reality through clinical scenarios in nursing education (Lopreiato, 2016) that support the development of clinical reasoning skills (Alfaro-LeFevre, 2010; Benner, Sutphen, Leonard, & Day, 2010; Meakim et al., 2013; Tanner, 2006) and enhance the safety and quality of clinical judgement (Del Bueno, 1994; Dillard, Sideras, Carlton, & Lasater, 2009; Jackson, Ignatavicius, & Case, 2004; Lasater, 2007; Meakim et al., 2013; Tanner, 2006). The high-fidelity simulators still present some disadvantages associated with the limited number of clinical scenarios available and a less dynamic clinical context simulation. These high-fidelity simulators require specific physical spaces, which causes problems for institutions with space management and highly demanding conservation financial resources. These constraints limit the availability of simulators for students' training outside the class environment. All these aspects compete with the financial constraints of a large number of nursing students and policy decision making to reduce public expenditure on higher education.

Currently, the developments in digital and virtual technology have eased the way to recreate reality using virtual patients depicted on a computer touch screen (clinical virtual simulation [CVS]). The CVS is the recreation of reality depicted on a computer screen and involves real people operating simulated systems. It is a type of simulation that places humans in a central role by exercising motor control skills, decision skills, or communication skills (Healthcare Simulation Dictionary, 2016).

The current technological developments have provided professionals with a new innovating tool, underpinned by a dynamic physiologic algorithm that combines clinical simulation and virtual reality simulation (Lopreiato, 2016), with problem-based learning and game design, all assembled in a three-dimensional technological tool. This immersive, dynamic learning environment not only encourages but also requires active and critical action-based learning.

The clinical virtual simulator Body Interact™ (http://bodyinteract.com/product/) builds competence in making clinical diagnoses, retaining knowledge, and integrating basic science concepts and proven medical and nursing protocols into clinical problems. The technology offers students and professionals alike a realistic experience with a life-like virtual patient, from diagnosis to treatment. This technology complements the current learning strategies in health education and is likely to contribute to a more rapid and effective learning process.

This CVS enables learning through experience or "how to think" and how to perform in real-world scenarios and patient-centric challenges. It is also adaptable across dozens of preconfigured and totally dynamic clinical scenarios (cardiology, endocrinology, neurology, respiratory, infectious diseases, trauma, pregnancy, and paediatrics). The technology also enables tracking of individual or group sessions, with a complete set of tools for learning management.

Existing evidence suggests the improvement of student's knowledge transferability acquired in the classroom (Tschannen, Aebersold, McLaughlin, Bowen, & Fairchild, 2012) through virtual simulation, even in the most complex clinical situations such as management of signs and symptoms and in areas such as inclusivity (Tiffany & Hoglund, 2016). Notwithstanding, it is still not possible to firmly

advocate this approach in nursing education (Foronda & Bauman, 2014; Foronda, Godsall, & Trybulski, 2013).

At the Nursing School of Porto, we are developing a knowledge base to support the integration of nursing clinical scenarios into a clinical virtual simulator underpinning the pregraduate nursing education curricula.

However, little is known about students' perceived ease, usefulness, and intention to use this new pedagogical strategy applied to nursing education.

To assess the students' perceived ease, usefulness, and intention to use this new pedagogical tool, we used the Technology Acceptance Model (TAM) (Davis, 1989, 1996) and determinants of the perceived ease of use (Venkatesh, 2000). TAM tests a theoretical model of the effect of system characteristics on user acceptance of computer-based information system, providing understanding about the user's acceptance processes, and information to support design and implementation of technology.

Methods

An exploratory, descriptive, and cross-sectional study was conducted using a quantitative approach. A nonprobabilistic sample of 426 pregraduate students was recruited from a Portuguese nursing school.

The aim of this study was to assess the ease, usefulness, and intention to use a clinical virtual simulator in pregraduate nursing education.

Students attending the second, third, and fourth years of the undergraduate degree in nursing were invited to participate in a theoretical-practical session of a clinical scenario resolution using a clinical virtual simulator in a physical table (47″) and later in a Web application. A structured briefing was conducted, with demonstration and debriefing during 22 sessions held by the researchers (Nurse Professors).

At the end of the presentation, a questionnaire was delivered to participants based on the TAM (Davis, 1989, 1996) and determinants of the perceived ease of use (Venkatesh, 2000). We accessed the three main variables of this model (ease, usefulness, and intention to use the technology). Our questionnaire included two sections. The first section addressed the sociodemographic data, and the second section included eight questions based on a 10-point Likert scale (from 1 [lower level], to 10 [higher level]) (Table 1).

A group of four experts in nursing informatics and in nursing education validated this questionnaire. The questionnaire revealed a Cronbach's alpha of 0.872 (n = 8 items), and item-total correlation ranged between 0.567 and 0.715. Data collection was performed from June to July 2016.

Descriptive and inferential statistics were used in the data analysis. Nonparametric statistical tests were conducted because the data did not fulfil the normality criteria. The Mann–Whitney *U* test was used to investigate the differences between groups, and Spearman's test was used to analyze the correlations between variables.

Exploratory factor analysis (EFA) was performed to simplify the presentation of results with the method for the extraction of the main components. The Kaiser–Meyer–Olkin (KMO), Bartlett's sphericity tests, and the varimax rotation method were also applied to measure the adequacy of the data.

Approvals were obtained from the ethics committee (reference 2016/1479) and from the nursing school.

Results

The sample comprised 426 pregraduate nursing students with an average age of 20.87 years (*SD* ± 2.74). From the total sample, 86.9% were female students, and 13.1% were male students. By academic year, 51.2% (n = 218) were second-year students, 36.6% (n = 156) were third-year students, and 12.2% (n = 52) were fourth-year students.

The students revealed a higher perceived ease, usefulness, and intention to use the clinical virtual simulator in an interactive table, in classes and in a Web application outside of the classes (Table 2).

At the Nursing School of Porto, the development of the nursing education curricula is characterized by in-class theoretical programmes in the two first academic years and clinical practice in the third and fourth years. The specificity of the curricula led researchers in this study to divide participants into two major groups, students with clinical experience and students with no clinical experience. Higher averages of perceived ease, usefulness, and

Table 1 Questionnaire Items (Translated From the Portuguese Version)

Questionnaire Items	
Item 1	How do you qualify the ease to use the simulator in an interactive table—touch screen (47″) in classes
Item 2	How do you qualify the ease to use the simulator in a Web application
Item 3	How do you qualify the usefulness of the simulator in the theoretical and theoretical–practical classes
Item 4	How do you qualify the usefulness of the availability of this simulator in a Web support
Item 5	What is your intention to use the simulator in classes
Item 6	What is your intention to use the simulator in your individual study, outside classes, in a Web application
Item 7	What is the perceived relevance of this simulator to your learning
Item 8	How can this simulator facilitate your learning as a nursing student

Table 2 Average of the Results of the Ease, Usefulness, and Intention to Use the CVS

	Ease		Usefulness		Intention	
Item	Average	Differences Between Groups With/No Clinical Experience, *p* Value	Average	Differences Between Groups With/No Clinical Experience, *p* Value	Average	Differences Between Groups With/No Clinical Experience, *p* Value
Interactive table—touch screen table in classes	9 (*SD* ± 1.08)	.002	9.59 (*SD* ± 0.74)	.02	9.47 (*SD* ± 0.82)	.022
Web environment—Web application	8.99 (*SD* ± 1.05)	.112	9.70 (*SD* ± 0.65)	.001	9.60 (*SD* ± 0.72)	.003
Global	8.99 (*SD* ± 1)	.008	9.64 (*SD* ± 0.62)	.003	9.53 (*SD* ± 0.7)	.005

Note. CVS = clinical virtual simulation.

intention to use the table touch screen and Web environment were found in students with no clinical experience compared with students with clinical experience, except for the ease in the use of Web environments. Globally, it was found that students with no clinical experience (second-year students, n = 218) perceived more ease ($p = .008$), usefulness ($p = .003$), and intention ($p = .005$) to use the clinical virtual simulator than the students with clinical experience.

The students showed an average of 9.55 ($SD \pm 0.73$) in the perceived relevance of the CVS in their learning process and of 9.71 ($SD \pm 0.59$) when asked about CVS acting as a facilitator of their learning process as nursing students.

The EFA (KMO = 0.838, Bartlett's test = 0) and the varimax rotation test with a two-factor solution explained 67.78% of the total variance. These two factors led to two new variables extracted from the arithmetic average of the obtained results (excluding null values). The new independent variables were perceived ease (results from items 1 and 2) and perceived usefulness and intention to use the clinical virtual simulator (results from items 3, 4, 5, 6, 7, 8) (Table 3).

This study also showed a moderate correlation between the perceived ease and usefulness and intention to use the immersive simulator ($r_s426 = 0.450$, $p < .001$). The female students showed higher values in perceived usefulness and intention to use the clinical virtual simulator than the male students ($p = .024$). Weak and negative correlation was also found between age and perceived usefulness and intention to use the immersive simulator ($r_s426 = -0.104$, $p = .05$).

Table 3 Perceived Ease to Use the CVS and Perceived Usefulness and Intention to Use the CVS

Perceived Ease to Use the CVS	Perceived Usefulness and Intention to Use CVS
8.99 (*SD* ± 1)	9.60 (*SD* ± 0.55)

Discussion

There is a new generational trend of younger students adopting the new ICTs as an important component of their social and educational life. The recent technological advances and innovation and the need to introduce new learning strategies in nursing education have been determinant in the establishment of partnerships with ICT companies engaged in the development of a clinical virtual simulator to improve clinical reasoning.

These accelerating societal changes boosted the development of a nursing knowledge base to be integrated into the clinical virtual simulator and the development of a methodology that is able to effectively assess the achieved outcomes. Currently, a questionnaire based on the TAM (Davis, 1986, 1996) and determinants of the perceived ease of use (Venkatesh, 2000) are being used in the Nursing School of Porto to assess the perceived ease, usefulness, and intention of pregraduate nursing students to use the clinical virtual simulator. The data reveal good psychometric properties of the questionnaire that support its use in this study (Cronbach's alpha of 0.872 [n = 8 items]). Additionally, the EFA supported by the quality of the data (KMO = 0.838, Bartlett's test = 0) was used to simplify the presentation of results.

The researchers involved in this study decided to only consider students attending the second, third, and fourth academic years. At the Nursing School of Porto, the first-year curriculum is focused on background knowledge development (e.g., biochemistry, pharmacology, anatomy, nurse fundamentals, etc.), and this led the researchers to decide to exclude these students from the study. The

distribution also reveals students' accessibility, as after having completed the second academic year, the students are placed in hospitals or health centres in the community to develop their clinical practice. Nonetheless, this sample represents almost 42% of students attending the second, third, and fourth years of the pregraduate nursing course.

The results of this study showed surprisingly high perceived ease, usefulness, and intention to use the CVS by nursing students. In fact, these important data show the perceived need for a resource that supports the students' clinical reasoning skills development. Similarly, the data reveal the preparedness and availability of younger generations to use immersive and virtual technology as a means to improve their education. The high results obtained for ease, usefulness, and intention to use CVS are in line with the results of studies conducted by Rosa (2017) and Marques (2017). These authors used the same questionnaire and CVS with emergency nurses in two Portuguese hospitals. The extracted data also revealed the preparedness and availability of emergency nurses to use immersive and virtual technology as a means to improve their lifelong learning.

The number of items used and the theoretical model could have influenced these results. Notwithstanding, this theoretical model has been widely used to provide understanding about the user's acceptance processes and information to support design and implementation of technology. These results clearly show students' perceived ease, usefulness, and intention to use CVS in their nursing education, regardless of the system's innovation level.

Female students revealed higher levels of perceived usefulness and intention to use the clinical virtual simulator than the male participants. This might be associated with differences in the knowledge acquisition process between genders. However, this particular finding is also likely to be influenced by the sample size differences between the two groups.

The differences found in the perceived ease and usefulness/intention to use the CVS between groups, students with and without clinical experience, have been determinant for the implementation of this innovative technology as a pedagogical strategy, particularly for students with no clinical experience. The use of this educational tool might be decisive to develop students' clinical reasoning and perception of self-efficacy on the decision-making processes, empowering them with fundamental skills to face the challenges of clinical practice. Additionally, the high scores found in the perception of students with clinical experience support the integration of this pedagogical strategy into the training programmes and continuous improvement of clinical judgement.

Rather than simply describing a trend related to state-of-the-art technological solutions, these results confirm the students' perceived ease, usefulness, and intention to use more user-friendly educational strategies supported by innovative devices.

These data also confront nursing professors with a new reality and yet a well-known issue that has been strongly debated for the past two decades. Since the pioneer writings of Prensky (2001), who first described the digital native generation and the digital immigrant generation, professionals have been striving to find solutions to facilitate the digital native students' learning processes.

New-generation students belong to a digital era, in which computers, phones, videos, games, and Internet are profoundly rooted in the society at all levels. Statistics show that in the European Union (EU), 55% of all houses have Internet access, and of these, 80% have a broadband Internet connection (European Commission, 2016). Also in the EU, 94% of people aged between 16 and 24 years are regular Internet users (European Commission, 2013).

Today, students and future generations of students will be constantly challenged with a new kind of stimulus, and this will most likely determine different learning processes and different brain structuration of the information (Prensky, 2001b). Professionals and particularly teachers need to keep up with these challenges and find new educational approaches underpinned by the gaming strategies responsive to the new societal demands in the nursing field.

It is important to consider that these students can access information in real time, use parallel processes and multitask, function best when networked, need instant gratification and frequent rewards, and prefer graphics to text and "games" to "serious work" (Prensky, 2001a).

The CVS complements the pedagogical strategies in use, providing easy access of professors, nursing schools, and students, in different environments, to a simulator that is able to incorporate dozens of dynamic clinical scenarios to improve nursing clinical reasoning and overcome the constraints of space and cost management.

This study contributes to understanding how we can meet these new challenges and take advantage of the digital native's abilities to improve quality and safety in nursing education.

Conclusion

These study results suggest that our students are prepared and highly motivated to use the CVS technology as a complementary strategy for their nursing education. The high levels of perceived ease, usefulness, and intention to use the CVS could be understood as a "surprise" effect related to this innovative technology, but most importantly, these findings are valid indicators and provide us with an opportunity to develop new approaches in nursing education to enhance skills and optimize the learning processes of our students. The most important issue is whether we are ready to develop and introduce innovation in pregraduate nursing curricula.

The development of ICT has opened new horizons in nursing education. We have witnessed the development and introduction of different high and low-tech simulators, largely contributing to improved nursing education quality. However, the societal challenges are driving populations into a digital era in which students' digital literacy, skills, and learning preferences need to be constantly met. The

CVS based on a physiologic dynamic algorithm is a solution adapted to the digital native students to support the development of their nursing clinical reasoning.

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References

Alfaro-Lefevre, R. (2010). *Applying nursing process: A tool for critical thinking*. Philadelphia, PA: Lippincott William & Wilkins.

Benner, P. (1984). *From novice to expert: Excellence and power in clinical nursing practice*. Menlo Park, CA: Addison-Wesley.

Benner, P., Sutphen, M., Leonard, V., & Day, L. (2010). *Educating nurses: A call for radical transformation*. San Francisco, CA: Jossey-Bass.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-339.

Davis, D. (1996). *A technology acceptance model for empirically testing new end-user information systems: theory and results*. Cambridge, MA: Sloan School of Management, Massachusetts Institute of Technology.

Del Bueno, D. J. (1994). Why can't new grads think like nurses? *Nurse Educator*, *19*, 9-11.

Dillard, N., Sideras, S., Carlton, K. H., & Lasater, K. (2009). A collaborative project to apply and evaluate the clinical judgment model through simulation. *Nursing Education Research*, *30*, 99-104.

European Commission. (2016). *Eurostat: Digital economy and society statistics—Households and individuals*. Retrieved from http://ec.europa.eu/eurostat/statistics-explained/index.php/Digital_economy_and_society_statistics_-_households_and_individuals#Internet_access

European Commission. (2013). *Eurostat: Archive: Internet use statistics—Individuals*. (modified at May 2016). Retrieved from http://ec.europa.eu/eurostat/statistics-explained/index.php/Archive:Internet_use_statistics_-_individuals

Foronda, C., & Bauman, E. B. (2014). Strategies to incorporate virtual simulation in nurse education. *Clinical Simulation in Nursing*, *10*, 412-418.

Foronda, C., Godsall, L., & Trybulski, J. A. (2013). Virtual clinical simulation: The state of the science. *Clinical Simulation in Nursing*, *9*, 279-e286.

Heimann, C., Prado, C., Moraes, R. R., Vidal, G. V., Liberal, D., Oliveira, G. K., & Barata, M. V. (2013). Acquiring nursing knowledge through the constructivist method. *Revista da Escola de Enfermagem da USP*, *47*, 997-1000.

Jackson, M., Ignatavicius, D. D., & Case, B. (2004). *Conversations in critical thinking and clinical judgment*. Pensacola, FL: Pohl.

Koutropoulos, A. (2011). Digital natives: Ten years after. *Journal of Online Learning and Teaching*, *7*, 525-538.

Lasater, K. (2007). Clinical judgment development: Using simulation to create an assessment rubric. *Journal of Nursing Education*, *46*, 496-503.

Lopreiato, J. O. (2016). *Healthcare simulation dictionary*. Retrieved from http://www.ssih.org/dictionary

Marques, D. (2017). Virtual immersive simulation in lifelong education in nursing. Master's thesis presented to Porto Nursing School to obtain the master's degree in nursing. Porto, 2017.

Meakim, C., Boese, T., Decker, S., Franklin, A. E., Gloe, D., Lioce, L., & Borum, J. C. (2013). Standards of best practice: Simulation standard I: Terminology. *Clinical Simulation in Nursing*, *9*(6S), S3-S11. https://doi.org/10.1016/j.ecns.2013.04.001.

Prensky, M. (2001a). Digital natives, digital immigrants Part 1. *On the Horizon*, *9*(5), 1-6.

Prensky, M. (2001b). Digital natives, digital Immigrants: Do they really think different? *On the Horizon*, *9*(6), 1-6.

Rosa, J. (2017). Virtual immersive simulation in lifelong education in nursing. Master's thesis presented to Porto Nursing School to obtain the master's degree in nursing. Porto, 2017.

Tanner, C. A. (2006). Thinking like a nurse: A research-based model of clinical judgment in nursing. *Journal of Nursing Education*, *45*, 204-211.

Tiffany, J. M., & Hoglund, B. A. (2016). Using virtual simulation to teach inclusivity: A case study. *Clinical Simulation in Nursing*, *12*(4), 115-122.

Tschannen, D., Aebersold, M., McLaughlin, E., Bowen, J., & Fairchild, J. (2012). Use of virtual simulations for improving knowledge transfer among baccalaureate nursing students. *Journal of Nursing Education and Practice*, *2*(3), 15-24.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into in the technology acceptance model. *Information Systems Research*, *11*(4), 342-365.