Computers & Education 108 (2017) 11–29

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Measuring the adoption and integration of virtual patient simulations in nursing education: An exploratory factor analysis

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A R T I C L E I N F O

Article history:
Received 2 November 2015
Received in revised form 2 January 2017
Accepted 6 January 2017
Available online 12 January 2017

Keywords:
Nursing education
Simulations
Technology adoption
Technology integration
Virtual patients

A B S T R A C T

This study sought to develop a valid and reliable instrument to identify the characteristics of computer-based, interactive, and asynchronous virtual patient simulations that nurse educators identify as important for adoption, and the subsequent curricular integration strategies they employed. Once these factors were identified, this study also sought to explore any relationships between the influential features for adoption and the ways in which the adopted virtual patients are integrated. Data were collected with the Virtual Patient Adoption and Integration in Nursing (VPAIN) survey, which was completed by 178 nurse educators who were currently using, or had previously used virtual patient simulations. Both exploratory factor analysis and correlation analysis were conducted. Through exploratory factor analysis, 55.6% of the variance in the VPAIN adoption subscale data was accounted for by the nine adoption factors identified: Trustworthiness, Worldbuilding, Pedagogy, Differentiation, Encouragement, Clarity, Evaluation, Administrative Pressure, and Visibility. The factor analysis also identified five factors within the integration subscale, which accounted for 53.3% of the variance: Hour Replacement, Intensive Integration, Leveling, Preparation, and Benchmarking. A correlation analysis was conducted to identify relationships between the adoption and integration factors.

1. Introduction

Healthcare in America is at a crossroads. As the population of the United States ages, more healthcare providers are needed, yet these same aging citizens are retiring from their healthcare careers. Nursing is one of the healthcare fields most in need of new professionals (Mancuso-Murphy, 2007; Sweigart, Burden, Carlton, & Fillwalk, 2014). The Bureau of Labor Statistics (2013) has identified registered nurses, and licensed practical and licensed vocational nurses as being among the occupations with the largest projected number of job openings due to growth and replacement needs; nearly one third of current registered nurses will reach retirement age within the coming decade (Health Resources and Services Administration, 2013). In addition, the Institute of Medicine has recommended that the proportion of nurses with baccalaureate degrees be increased from 50% to 80% by 2020 (Committee on the Robert Wood Johnson Foundation Initiative on the Future of Nursing, 2011).

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http://dx.doi.org/10.1016/j.compedu.2017.01.005

However, to exacerbate the issue, there are shortages of nurse educators as well, and educational institutions cannot meet the demand of those applying to their programs (Dutile, Wright, & Beauchesne, 2011; Mancuso-Murphy, 2007). The American Association of Colleges of Nursing reported that in 2013 nearly 79,000 qualified applicants were turned away from nursing programs due to the shortage of educators (Ramachandran, 2014). In order to meet this need for nurse educators and researchers, the Institute of Medicine has also called for the number of nurses with a doctorate to be doubled by 2020, which will of course also require more educators to teach them.

One of the most pressing issues in the education of nurses is that of promoting patient safety through the prevention of medical errors. Medical errors are a significant cause of patient harm and morbidity in health care today (E. J. Lewis, Baernholdt, & Hamric, 2013). In the education of health professionals, educators in all disciplines have sought to teach their students the diagnostic reasoning and communication skills, and to foster the teamwork and self-confidence needed to provide safe and effective care in order to prevent these errors (Consorti, Mancuso, Nocioni, & Piccolo, 2012; Cook, Erwin, & Triola, 2010). To this end, simulation is an established and effective method of providing a safe, risk-free environment where students can practice new skills and apply new knowledge without posing a threat to actual patients (Nehring & Lashley, 2009).

There is strong evidence that the use of simulation can meet identified learning objectives and increase self-reported measures of engagement, satisfaction, and self-confidence (Arnold, Johnson, Tucker, Chesak, & Dierkhising, 2011; Cook et al., 2010; Howard, Englert, Kameg, & Perozzi, 2011). Existing literature also identifies simulation as an effective educational strategy for the achievement of patient safety learning outcomes (Blum & Parcells, 2012; Cook et al., 2012; Thornock, 2013). A recent report by the National Council of State Boards of Nursing suggests that simulations can be used as a substitution for up to 50% of traditional clinical experiences as long as certain conditions are met during implementation (Hayden, Smily, Raij, Kardong-Edgren, & Jeffries, 2014). Although there is limited research demonstrating that simulation reduces medical errors and improves patient safety, quality of life, and survival outcomes themselves, simulation has been identified by anesthesiology researchers as a successful strategy for improving patient safety, decreasing patient morbidity, identifying latent errors, and facilitating improvements to process (Aebersold & Tschannen, 2013; Shear, Greenberg, & Tokarczyk, 2013). However, the use of simulation to positively affect patient outcomes and safety for nursing professionals lacks significant empirical evidence (Aebersold & Tschannen, 2013). While it is difficult to pinpoint simulation as the cause of decreased medical errors, Durham and Alden (2008) described patient safety as a complex concept that includes not only the prevention of medical errors, but also the development of critical thinking and decision-making, effective communication, and the promotion of teamwork, all of which have been identified as outcomes achieved through the use of simulations (Aggarwal et al., 2010; Stanley & Latimer, 2011; Stevens et al., 2006; Stroup, 2014; Sweigart et al., 2014).

Virtual patients (See Fig. 1) are an emerging form of simulation technology in health professions education, and a market projected to reach $508.7 million in 2019 (Meticulous Research, 2014). Nursing education is one of the health profession's fields that has made use of simulation over the past few decades, and nursing education programs are increasingly turning to

Fig. 1. A virtual patient from the University of Southern California Institute of Creative Technologies. (Alan Levine, licensed under CC BY 2.0).

virtual patient simulations due to an increased demand for professionals in the field, a shortage of nurse educators, a deficiency in the clinical hours available to nursing students, and an increasing number of online programs and nontraditional students (Dutile et al., 2011; Sweigart et al., 2014). Virtual patient simulations offer several benefits over other types of manikin and standardized patient simulations due to their flexibility of implementation (Consorti et al., 2012; Dutile et al., 2011). Virtual patients do not require the financial investment or clinical lab space of a high-fidelity patient simulator, which is a particular advantage for online and blended programs, as well as smaller nursing programs with limited space available (McKeon, Norris, Cardell, & Britt, 2009). Virtual patients also do not require the time investment that is necessary to train a standardized patient actor, nor are they restricted by the space and scheduling limitations of examining a standardized patient actor (Kiegaldie & White, 2006; Stevens et al., 2006; Triola et al., 2006).

While virtual patient simulations offer many benefits, they are cost-prohibitive to develop internally, with estimated costs ranging from $10,000 to $50,000, plus the cost of maintenance (Cendan & Lok, 2012; Cook & Triola, 2009; Huang, Reynolds, & Candler, 2007). As a result, many nursing programs adopt one or more of the commercially developed virtual patient simulation applications available. Due to the flexibility afforded by asynchronous computer-based simulations, educators may use virtual patients to teach their students new content within the classroom; to provide an environment off campus in which to allow their students to practice new skills and apply new knowledge; or as a summative assessment in order to evaluate the competency of their distance education students who do not have access to a standardized patient actor. However, prior research on virtual patient simulations in nursing has focused on the efficacy of the modality or barriers to implementation rather than exploring the most effective ways in which virtual patient simulation could be integrated into the curriculum (Cook & Triola, 2009; Tworek, Jamniczky, Jacob, Hallgrimsson, & Wright, 2013). Reasons for adoption of a particular virtual patient application are rarely discussed, and are infrequently associated with integration strategies. There is a significant gap in the literature on the ways in which virtual patient simulations are successfully integrated. The field of virtual patient simulations also lacks a validated instrument to measure the adoption and integration of these technologies.

1.1. Purpose

The purpose of this study was to develop a valid and reliable instrument to identify the factors that influence a nurse educator's decision to adopt a virtual patient simulation technology, as well as the subsequent curricular integration methods used to implement the technology. This study also sought to explore any relationships between the influential adoption factors and the ways in which the adopted simulations are integrated. This study sought to answer the following research questions:

RQ1. Is the Virtual Patient Adoption and Integration in Nursing instrument a valid measure of the adoption and integration of virtual patients in nursing education?
RQ2. What features do nurse educators consider to be important when choosing virtual patient simulation technology for their curriculum?
RQ3. How are nurse educators integrating their adopted virtual patient simulation into their curriculum?
RQ4. Is there a relationship between the important features of virtual patient simulations and curriculum integration methods used?

As more nursing programs turn to virtual patient simulations to address their needs, it is important to understand how educators are choosing virtual patients, how they then integrate the simulations, and any relationships between adoption and integration. This knowledge will have important implications for the teaching practices of nurse educators, and for the design of virtual patient simulations, as any identified trends in behavior may enable virtual patient providers to develop more precise virtual patient simulations for nursing education in the future.

1.2. Conceptual framework

The conceptual framework of this study employed Diffusion of Innovations (Rogers, 2003) to provide structure to the construct of virtual patient adoption in nursing education. Miller and Bull (2013) found that nurse educators viewed simulation as a separate instructional entity burdened with the political ramifications of competing for simulation program funding and the pressure to be perceived as being innovative. Miller and Bull (2013) argued that to disseminate simulation technology, educators' attitudes and decisions about simulation must be understood in order to avoid fragmented teaching and learning, and to support the achievement of learning outcomes. This study applied the five intrinsic characteristics of innovations described by Rogers (2003) to the range of characteristics and factors considered by nurse educators when making the decision to adopt or reject a virtual patient simulation into their curriculum. These attributes are the *compatibility* (the extent to which an innovation is considered to align with a prospective adopter's existing framework of experiences, values, and needs), *complexity* (the extent to which an innovation is considered to be challenging to use or understand), *observability* (the extent to which an innovation's effects are evident to others), *relative advantage* (the extent to which an innovation is considered superior than the innovation that preceded it), and *trialability* (the extent to which an innovation can be demonstrated or tested without full adoption) of an innovation (Rogers, 2003).

2. Method

This study developed the Virtual Patient Adoption and Integration in Nursing (VPAIN) survey to identify and measure the factors related to technology adoption and integration by nurse educators who use computer-based, interactive, asynchronous virtual patient simulations. The VPAIN instrument was designed using existing research, along with interviews conducted with content experts. The VPAIN instrument then was pilot tested to establish its face and content validity prior to its administration to the study participants (AERA, APA, & NCME, 2014; Dillman, Smyth, & Christian, 2014; Fishman & Galguera, 2003; Van Someren, Sandberg, & Barnard, 1994).

2.1. Survey development process

After a review of the literature, interviews were conducted with 10 content experts. The 10 content experts interviewed in the development of the first draft of the VPAIN survey instrument included four undergraduate nurse educators and three graduate nurse educators with experience using virtual patient simulations in their curriculum, one nursing college dean, one virtual patient simulation trainer, and one virtual patient marketing professional. Questions were asked to establish experience and expertise, and to explore the factors and features that could be considered important in the adoption of a virtual patient simulation, as well as the differing strategies through which a virtual patient simulation could be integrated into nursing education curriculum.

Using both the literature reviewed and the coded interview transcripts, the dimensions of the constructs were conceptualized, and then used to draft the item pool. Within the five intrinsic characteristics of innovations identified in Diffusion of Innovations theory (compatibility, complexity or simplicity, observability, relative advantage, and trialability), a total of 34 adoption subdomains were identified, which were then consolidated into 10 conceptual domains. For the construct of integration, no existing educational technology integration theories were found to be applicable to the construct of virtual patient integration in nursing education. Through coding nine subdomains were identified. These subdomains were then consolidated into three conceptual domains: strategy, relationship, and management. The number of subdomains identified was sufficient for saturation. Two items were drafted for each subdomain for the first draft of the survey instrument.

The first draft of the VPAIN instrument included two items within each subdomain identified during conceptualization, for a total of 68 adoption items and 18 integration items. The first draft of the VPAIN survey instrument also included 10 sample eligibility and demographic items. A Qualtrics template was used to create matrices that contained four-to-eight items each, clustered by associated domains. The adoption construct matrices contained a four-point unipolar scale (Not at all Important; Slightly Important; Important; Very Important), and the integration construct matrices contained a five-point unipolar Likert-type scale (Never; Rarely; Sometimes; Often; Always).

2.2. Pilot test of VPAIN survey

The first formatted version of the VPAIN survey instrument was evaluated for evidence of content and face validity through expert review and cognitive interviews. This process ensured that the data collected corresponded to the intent for which the instrument was designed to measure. The participants in the pilot test expert review consisted of the same 10 content experts interviewed in the development of the first draft of the VPAIN instrument. This ensured that dimensions conceptualized adhered to the original constructs of the experts. The original 10 content experts were sent a modified version of the first draft of the VPAIN survey to complete. The items' response options were changed so that the content experts could match each item with its conceptual domain. These original content experts were provided with a link to the modified first draft of the VPAIN survey instrument, as well as a document that included the definitions for subdomains within each conceptual domain. This modified instrument also included additional open-text questions asking the experts to comment on the accuracy, clarity, and comprehensiveness of the items. The data from the survey were used to evaluate the content validity and alignment of the items drafted for each dimension. Eight of the ten original participants completed the modified first draft of the instrument.

A second group of five additional nurse educators were interviewed and asked to read each item in the first draft of the VPAIN survey instrument out loud while describing their reaction and thoughts on each item in a think aloud protocol. This process established the face validity of the instrument, as well as clarified the intent of the items and provided new perspectives on the VPAIN instrument domains.

The results of the reviews from the eight original experts were used to assess each item for agreement on its conceptual domain for the purpose of establishing content validity, and to refine any items specifically mentioned as problematic in the post-survey questions. The expert review yielded substantial disagreement on many of the items; only six items within both of the adoption and integration constructs resulted in unanimous agreement on the intended conceptual domain. Though the expert review process was complex, and the inclusion of an external reference document was cumbersome, all items with less than a majority of participants identifying the intended conceptual domain were evaluated for necessary refinement, using the results from the cognitive interviews for specific direction for improvement.

Using the results of the expert reviews and cognitive interviews, a final draft of the VPAIN survey instrument was constructed (Appendix A). As a result of the pilot test, a definition of virtual patients along with a picture and new instructions were added, and page breaks were inserted between the matrices. Fourteen new items were added, four items were deleted, and fifty-five items were refined, edited, or moved to a new order within the instrument. Two matrices were consolidated, and the subdomain or conceptual domain was changed for four items. The scale for the adoption items was modified from a four-point Likert-type scale, to a five-point scale (Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely).

2.3. Data collection procedures

The final version of the VPAIN survey instrument included four sample eligibility items, ten demographic items, seventy-one adoption items, and twenty-one integration items. The survey was open to participants from February 23, 2015 through to March 30, 2015. The population of nurse educators using virtual patient simulations was unknown do the privacy of customer databases maintained by virtual patient providers, and the lack of comprehensive documentation of open-source and internally-developed virtual patients. Because there was no existing list of the population of nurse educators who have used virtual patient simulations in their courses, the population sample for this study was identified through convenience and snowball sampling. An invitation to participate was distributed to the users of two commercial virtual patient software programs by email, and recruitment notices were posted to simulation and nursing education forums and social networking groups. Targeted recruitment ads were also published to Twitter, Facebook, and LinkedIn.

After data collection, an error was discovered in the Qualtrics survey. For the third of the three integration subscale matrices, the response scale was missing the fifth option of “Always”. As a result, the last seven items of the VPAIN survey (those within the conceptual domain of management) had only a four-point Likert-type scale including never, rarely, sometimes, and often as response options. However, regression scores were used for the factors scores in the correlation analysis, which eliminated the affect of this variance between the scales.

2.4. Data analysis procedures

The VPAIN survey was developed for the purpose of answering the research questions of why nurse educators adopt virtual patient simulations, how they use those programs in their courses, and if there are any relationships between adoption and integration behaviors. To answer these questions, the data collected were analyzed first to establish the internal consistency of the instrument. Next, Exploratory Factor Analysis (EFA) was conducted to identify the underlying structure within the constructs of adoption and integration. Factor reliability using Cronbach's alpha (Nunnally & Bernstein, 1994) was adopted and correlation analyses were then conducted on the identified factors. The software used to conduct all of these analyses was SPSS version 21. An alpha level of 0.05 was used for the statistical tests.

2.5. Participant description

The population for this study was nurse educators teaching in associate's, baccalaureate, master's, and doctorate of nursing programs who were currently using or had previously used computer-based, interactive, asynchronous virtual patient simulations in their curriculum and were part of the decision-making process to adopt the technology. A total of 421 participants started the VPAIN survey. Of these, 398 indicated that they were nurse educators. Of the 398 nurse educators, 268 were currently using virtual patient simulations, and an additional 66 nurse educators had used virtual patient simulations in the past. Of the 334 nurse educators who were currently using or had previously used virtual patient simulations, 194 were decision-makers in the adoption of the virtual patient program, and were eligible to participate in the study. Cases that included responses for the adoption construct matrices, and at least the first of the three integration construct matrices were considered to be complete. There were 178 completed cases for data analysis. Of the 178 complete VPAIN survey responses,

Table 1
Faculty demographics.

Institution type	*N*	%	Faculty status	*N*	%	Years teaching	*N*	%
Technical institution	5	2.8	Adjunct	15	8.4	1 year	4	2.2
Public associates	14	7.9	Instructor	33	18.5	2-4 years	42	23.6
Private associates	1	0.6	Assistant Professor	59	33.1	5-7 years	32	18
For-profit associates	5	2.8	Associate Professor	23	12.9	8-10 years	30	16.9
Public baccalaureate	13	7.3	Professor	12	6.7	11-15 years	25	14
Private baccalaureate	7	3.9	Clinical Instructor	8	4.5	16-20 years	18	10.1
For-profit baccalaureate	6	3.4	Clinical Assistant Professor	20	11.2	21-25 years	10	5.6
Public master's	16	9	Clinical Associate Professor	3	1.7	26-30 years	7	3.9
Private master's	8	4.5	Clinical Professor	1	0.6	More than 30 years	7	3.9
For-profit master's	6	3.4	Missing	4	2.2	Missing	3	1.7
Public doctorate	50	28.1						
Private doctorate	36	20.2						
For-profit doctorate	10	5.6						
Missing	1	0.6						

Table 2
Program for which a virtual patient was first adopted.

Program type	*N*	%
Licensed Practical/Vocational Nursing	8	4.5
Associate Degree in Nursing	18	10.1
LPN-to-ADN	2	1.1
Bachelor of Science in Nursing	48	27
Second Degree BSN	2	1.1
RN-to-BSN	37	20.8
Master of Science of Nursing	53	29.8
Post Master Certificate	0	0
Doctor of Nursing Education	0	0
Doctor of Nursing Practice	5	2.8
Doctor of Philosophy	0	0
Other	3	1.7
Missing	2	1.1

Table 3
Virtual patient length of use and funding agent.

Semesters of use			Purchaser		
	N	%		*N*	%
1 semester	33	18.5	The nursing program, using grant funding	9	5.1
2 semesters	47	26.4	The nursing program, using its own funds	26	14.6
3 semesters	48	27	The students, by direct purchase	104	58.4
4 semesters	19	10.7	The students, through a lab fee	31	17.4
More than 4 semesters	31	17.4	The virtual patient does not cost any money	4	2.2
			Missing	2	2.2

154 respondents were currently using an asynchronous, computer-based virtual patient in their courses at the time of the survey. The remaining 24 respondents reported having used an asynchronous, computer-based virtual patient in their courses in the past.

Respondents were asked to report the number of years they had taught in a nursing program, their faculty status, and the type of institution at which they taught (Table 1). Because many educators teach in more than one type of degree program, respondents were asked to indicate all of the programs in which they currently taught. However, because educators may select a virtual patient for the different programs in which they teach at different times and for different purposes, and one of the research questions of this study was to identify the influential factors for which a virtual patient was adopted, respondents were also asked for which nursing program they first adopted a virtual patient (Table 2).

Respondents were asked to select the methods through which they delivered the content of their courses, and the length of their course semesters. Because educators teach in multiple programs, respondents were asked to select all that applied. Traditional, face-to-face delivery was the most frequent delivery method. One hundred and four educators delivered their course content face-to-face, which was defined as “traditional, classroom-based instruction, with no content delivered online.” Seventy-five nurse educators delivered their content through web-enhanced methods, defined as “classroom-based instruction, with up to 30% of content delivered online.” Sixty-five educators delivered their content through blended or hybrid methods, defined as “both classroom-based and web-based instruction, with up to 80% of content delivered online.” Seventy-eight educators taught at least one of their courses fully online, defined as “web-based instruction, with more than 80% of content delivered online. The majority of faculty taught in traditional semesters. One hundred and thirty-six faculty taught in a traditional semester, defined as lasting 12 weeks or more. Sixty-three faculty indicated that they taught in accelerated semesters, defined as lasting 11 weeks or fewer.

Respondents were asked to indicate for how many semesters they had used a virtual patient program, and who funded the use of the virtual patient program (Table 3). Finally, respondents were asked if they evaluated the virtual patient program prior to adoption. Only 7.9% ($N = 14$) did not evaluate the program prior to adoption and integration, indicating that the majority (91%) of nurse educators informed their adoption decision by assessing the quality of the virtual patient program in some way.

3. Results

The internal consistency of the adoption construct items ($N = 71$) and integration construct items ($N = 21$) was measured at $\alpha = 0.947$and $\alpha = 0.725$, respectively. These coefficients are above the general recommendation of 0.7, and higher than the 0.6 minimum level suggested for a new scale (Nunnally & Bernstein, 1994). The Cronbach's alpha for the complete VPAIN instrument was $\alpha = 0.930$.

3.1. Exploratory factor analysis

In order to explore the underlying structures within the adoption and integration constructs, EFA was conducted on each subscale. The EFA extraction method used on the adoption and integration subscales was principal axis factoring. The rotation method selected was promax, as an oblique rotation allows for correlation between the factors (Costello & Osborne, 2005).

When identifying the appropriate sample size for factor analysis, recent research has determined that a sample size is most affected by the number of variables, the number of factors, the ratio of variables to factors, and the strength of the communalities (MacCallum, Widaman, Zhang, & Hong, 1999; Mundfrom, Shaw, & Tian Lu, 2005). Mundfrom et al. (2005) found that, for a fixed number of factors, as the number of variables increased, the effect of the level of communality decreased, and as a result of their research recommended a ratio of variables to factors of at least 7:1. The variable-to-factor ratios for the subscales of this study were approximately 8:1 (adoption) and 4:1 (integration). The level of communality among the items was considered wide (ranging between 0.20 and 0.80) for both the adoption ($M = 0.49$) and integration ($M = 0.40$) subscales. Using the recommended guidelines suggested by Mundfrom et al. (2005) for these conditions, and considering the number of cases acquired for this study ($N = 178$), the adoption subscale easily met the criteria to achieve excellent agreement, and integration subscale met the criteria to achieve good agreement.

Parallel analysis was used to help establish the number of factors to retain. The parallel analyses for the adoption and integration subscales were run using the SPSS syntax provided by O'Conner (2000). The raw data permutation was conducted for Principal Axis Factoring/Common Factor Analysis. The number of cases used was 153 for the adoption subscale, and 168 for the integration subscale, after listwise deletion. One thousand random data sets were run through the Monte Carlo simulation for the parallel analysis. The 95th percentile of the random data eigenvalue distribution was specified as a comparison metric, as it has been determined to be a more robust comparison than that of the mean of the random data eigenvalue (Ledesma & Valero-Mora, 2007). For parallel analysis, factors are retained if the eigenvalue for the actual data is larger than the 95th percentile of the eigenvalue of the random data generated (Ledesma & Valero-Mora, 2007; Ruscio & Roche, 2012).

The number of factors identified by the parallel analyses was nine for the adoption items ($N = 71$), and eight for the integration items ($N = 21$). All of the factors retained for both subscales had an eigenvalue >1. A range of factor analyses with different loadings based on the scree tests were run for each subscale to confirm that the number of factors identified by the parallel analyses was the cleanest factor structure and the best fit for the data. It was determined through these multiple criteria that the nine factors indicated by the parallel analysis should be retained for the adoption subscale, accounting for 55.6% of the variance (Table 4). The parallel analysis indicated that eight factors should be retained for the integration subscale, however, the scree test showed that the sharpest drop between eigenvalues was between five and six factors (Table 5). The five-factor model for integration items had fewer crossloadings, and only one factor with fewer than three items (as opposed to three factors with fewer than three items under the eight-factor model). Using these multiple criteria to identify the cleanest factor structure, five factors were retained for the integration subscale, accounting for 53.3% of the variance.

3.2. Adoption factors

For the EFA run with nine factors for the adoption subscale, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.815, which is above the minimum threshold of 0.5 suggested by Kaiser (1974). Bartlett's test of sphericity had a Chi square of 7191.763 ($p < 0.001$), which indicated that the intercorrelation matrix contained variables with sufficient collinearity for analysis (Bartlett, 1950). The rotation for the adoption subscale converged in 18 iterations. The factor loadings were evaluated, and using the items and the weight of their loadings on each factor, a descriptive label was assigned to each factor. The adoption factors identified were: *Trustworthiness, Worldbuilding, Pedagogy, Differentiation, Encouragement, Clarity, Evaluation, Administrative Pressure*, and *Visibility*. Table 4 contains the variance explained by each factor, the number of items included, and the factor's Cronbach's alpha.

The items within the *Trustworthiness* factor related to issues of confidence, usability, and an expectation that the program was accurate and appropriate for educators and their students. The factor of *Trustworthiness* contained ten items from the

Table 4
Adoption factor total variance explained and reliability.

Factor	Eigenvalues			Number of items	Cronbach's alpha
	Total	% of variance	Cumulative variance		
1. Trustworthiness	18.365	25.866	25.866	10	0.848
2. Worldbuilding	4.959	6.984	32.850	14	0.873
3. Pedagogy	3.289	4.632	37.482	10	0.873
4. Differentiation	2.663	3.751	41.233	10	0.802
5. Encouragement	2.347	3.305	44.538	7	0.828
6. Clarity	2.102	2.961	47.500	7	0.796
7. Evaluation	2.013	2.835	50.334	7	0.765
8. Administrative pressure	1.961	2.763	53.097	3	0.825
9. Visibility	1.805	2.542	55.638	3	0.750
10.	1.656	2.332	57.970		

Table 5
Integration factor total variance explained and reliability.

Factor	Eigenvalues			Number of items	Cronbach's alpha
	Total	% of variance	Cumulative variance		
1. Hour replacement	3.624	17.259	17.259	4	0.689
Intensive integration	2.458	11.703	28.962	7	0.471
Leveling	2.152	10.247	39.209	4	0.669
Preparation	1.545	7.357	46.566	4	0.558
Benchmarking	1.420	6.763	53.329	2	0.521
	1.151	5.481	58.81		

three conceptual domains of congruity, accessibility, and dependability. The items within the *Worldbuilding* factor related to fidelity, flexibility, control over the virtual patient, and the structure of the learning environment. This factor was the largest and most complex, describing a desire to exert control over a realistic and well-ordered virtual world. The factor of *Worldbuilding* contained fourteen items from the five conceptual domains of realism, technological advantage, congruity, adaptability, and accessibility. The items within the *Pedagogy* factor related to the learning outcomes, curricular fit, and perceived learning opportunities of the virtual patient program. The factor of *Pedagogy* contained ten items from the three conceptual domains of technological advantage, congruity, and confirmation. The items within the *Differentiation* factor related to the characteristics of virtual patients that distinguish it from other simulation technologies, and the perceived value by educators and students. The factor of *Differentiation* contained ten items from the three conceptual domains of technological advantage, perception, and accessibility. The items within the *Encouragement* factor related to issues of students' acceptance, curriculum committees' input, and the support of other nurse educators within the department and through virtual patient program user groups. The factor of *Encouragement* contained seven items from the two conceptual domains of confirmation and external influence. The items within the *Clarity* factor related to issues of insight, confidence, training and support materials, and the ability to review or try the program prior to adoption. The factor of *Clarity* contained seven items from the four conceptual domains of technological advantage, perception, dependability, and trialability. The items within the *Evaluation* factor related to the assessment, grading, feedback, and results of the virtual patient program. The factor of *Evaluation* contained seven items from the two conceptual domains of technological advantage and congruity. The items within the *Administrative Pressure* factor related to the influence of other departmental staff and institutional administration to adopt the virtual patient. The factor of *Administrative Pressure* contained three items from the one conceptual domain of external influence. The items within the *Visibility* factor related to issues of awareness of the virtual patient program. The factor of *Visibility* contained three items from the two conceptual domains of trialability and confirmation.

3.3. Integration factors

For the EFA run with five factors for the integration subscale, the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.691, which is above the minimum threshold of 0.5 suggested by Kaiser (1974). Bartlett's test of sphericity had a Chi square of 906.858 ($p < 0.001$), which indicated that the intercorrelation matrix contained variables with sufficient collinearity for analysis (Bartlett, 1950). The rotation for the integration subscale converged in eight iterations. The factor loadings were evaluated, and using the items and the weight of their loadings on each factor, a descriptive label was assigned to each factor. The integration factors identified were: *Hour Replacement, Intensive Integration, Leveling, Preparation,* and *Benchmarking*. Table 5 contains the variance explained by each factor, the number of items included, and the factor's Cronbach's alpha. One factor (*Intensive Integration*) contained two items with negative factor loadings, which were negatively correlated with the behavior described by the factor. Three of the five factors had poor reliability, falling below the minimum of 0.6 suggested by Nunnally and Bernstein (1994) for a new scale, suggesting that the factor items do not reliably represent the domains being measured.

The items within the *Hour Replacement* factor related to the using the ungraded time spent with the virtual patient as a substitute for lab, clinical, or practicum hours. The factor of *Hour Replacement* contained four items from the two conceptual domain of relationship and management. The items within the *Intensive Integration* factor related to a deep and more labor-intensive curricular integration of the virtual patient, with regular graded assignments, and user-created worksheets and rubrics to assess targeted skills. The factor of *Intensive Integration* contained five items with positive factor loadings from the two conceptual domains of strategy and management. This factor also contained two items with negative factor loadings (−0.384) and (−0.364) from the conceptual domain of strategy, which negatively correlated with the factor. When the two items with negative factor loadings and the item with a loading lower than 0.30 were excluded from the reliability analysis, Cronbach's alpha for this factor was $\alpha = 0.694$, however, because the three items added greater depth to the meaning of the *Intensive Integration* factor, this was not deemed a sufficient enough justification for removal of the items from the factor. The items within the *Leveling* factor related to the use of the virtual patient to demonstrate progressively complex content, connect concepts, and assess proficiency. The factor of *Leveling* contained four items from the three conceptual domains of strategy, relationship, and management. The item "Assigned the virtual patient as a summative assessment instrument to evaluate your students' proficiency at the conclusion of your course," crossloaded with the factor of *Intensive Integration*, as it loaded at (0.250) for *Leveling* and at (0.245) for *Intensive Integration*. The items within the *Preparation* factor related to the use

Table 6
Adoption and integration factor correlation matrix.

Pearson Correlations	1	2	3	4	5	6	7	8	9	1	2	3	4	5
Adoption Factors														
1. Trustworthiness	1	0.445[a]	0.506[a]	0.557[a]	0.274[a]	0.243[a]	0.014	-0.306[a]	0.299[a]	0.007	0.097	0.128	0.003	−0.022
2. Worldbuilding	0.445[a]	1	0.582[a]	0.652[a]	0.362[a]	0.518[a]	0.137	0.076	0.360[a]	0.122	0.270[a]	0.261[a]	0.042	0.123
3. Pedagogy	0.506[a]	0.582[a]	1	0.676[a]	0.393[a]	0.464[a]	0.213[a]	−0.105	0.193[a]	0.086	0.123	0.323[a]	0.032	0.051
4. Differentiation	0.557[a]	0.652[a]	0.676[a]	1	0.456[a]	0.484[a]	−0.008	−0.123	0.334[a]	0.093	0.194[a]	0.344[a]	0.028	0.059
5. Encouragement	0.274[a]	0.362[a]	0.393[a]	0.456[a]	1	0.173[a]	−0.156	0.219[a]	0.168[a]	0.242[a]	−0.1	0.189[a]	0.16	0.001
6. Clarity	0.243[a]	0.518[a]	0.464[a]	0.484[a]	0.173[a]	1	0.176[a]	0.094	0.097	−0.046	0.317[a]	0.183[a]	0.039	0.068
7. Evaluation	0.014	0.137	0.213[a]	−0.008	−0.156	0.176[a]	1	0.072	−0.102	−0.028	0.207[a]	0.163[a]	−0.122	0.049
8. Administrative Pressure	-0.306[a]	0.076	−0.105	−0.123	0.219[a]	0.094	0.072	1	−0.065	0.154	0.02	−0.011	0.222[a]	0.067
9. Visibility	0.299[a]	0.360[a]	0.193[a]	0.334[a]	0.168[a]	0.097	−0.102	−0.065	1	0.041	0.128	0.213[a]	0.197[a]	0.116
Integration Factors														
1. Hour Replacement	0.007	0.122	0.086	0.093	0.242[a]	−0.046	−0.028	0.154	0.041	1	0.017	0.091	0.253[a]	0.223[a]
2. Intensive Integration	0.097	0.270[a]	0.123	0.194[a]	−0.1	0.317[a]	0.207[a]	0.02	0.128	0.017	1	0.442[a]	−0.087	0.195[a]
3. Leveling	0.128	0.261[a]	0.323[a]	0.344[a]	0.189[a]	0.183[a]	0.163[a]	−0.011	0.213[a]	0.091	0.442[a]	1	0.192[a]	0.379[a]
4. Preparation	0.003	0.042	0.032	0.028	0.16	0.039	−0.122	0.222[a]	0.197[a]	0.253[a]	−0.087	0.192[a]	1	0.348[a]
5. Benchmarking	−0.022	0.123	0.051	0.059	0.001	0.068	0.049	0.067	0.116	0.223[a]	0.195[a]	0.379[a]	0.348[a]	1

[a] Correlation is significant at the 0.05 level (2-tailed).

of the virtual patient as a pass/fail activity to teach content or practice concepts prior to lecture, classroom activities, or lab hours. The factor of *Preparation* contained four items from the three conceptual domains of strategy, relationship, and management. When the item with a loading lower than 0.30 was excluded from the reliability analysis, Cronbach's alpha for this factor was $\alpha = 0.634$, however, because the item added greater depth to the meaning of the *Preparation* factor, this was not deemed a sufficient enough justification for removal of the item from the factor. The items within the *Benchmarking* factor related to the use of the virtual patient as a formative assessment during the course, and to reinforce content after delivery through lecture or lab. The factor of *Benchmarking* contained two items from the conceptual domain of strategy.

3.4. Correlation analysis

To answer the research question exploring the relationship between important features of virtual patient simulations and curriculum integration methods, a correlation analysis was conducted on the adoption and integration factors (Table 6). Correlations significant at the level of 0.05 within the adoption factors were consistent within the first six factors of *Trustworthiness, Worldbuilding, Pedagogy, Differentiation, Encouragement,* and *Clarity,* with small (<0.20) to large (>0.40) effect sizes (Cohen, 1988) ranging from $r = 0.173$ (*Encouragement* with Clarity) to $r = 0.676$ (*Pedagogy* with *Differentiation*). However, the highest correlations were among the first four factors of *Trustworthiness, Worldbuilding, Pedagogy,* and *Differentiation*, all with strong relationships, the lowest being for *Trustworthiness* with *Worldbuilding.* One of the three remaining adoption factors, *Visibility*, also correlated with the first five factors (*Trustworthiness, Worldbuilding, Pedagogy, Differentiation*, and *Encouragement)*, but did not have a significant correlation with the sixth factor of *Clarity.* The relationships between *Visibility* and the first five factors were weak to moderate, ranging from $r = 0.168$ (*Encouragement*) to $r = 0.360$ (*Worldbuilding*). The factors of *Evaluation* and *Administrative Pressure* had fewer significant relationships with the other adoption factors. *Evaluation* had a significant moderate relationship with the factor of *Pedagogy*, as well as a weak relationship with the factor of *Clarity*. The factor of *Administrative Pressure* also correlated significantly with only two other adoption factors. The only significant negative correlation in the analysis was between the factors of *Administrative Pressure* and *Trustworthiness*. The other correlation with *Administrative Pressure* was with the factor of *Encouragement*. Both relationships with the factor of *Administrative Pressure* were moderate in strength.

There were several correlations significant at the level of 0.05 within the integration factors, the most consistent of which was for the factor of *Benchmarking*, which had a weak to moderate relationship with all of the other four factors of *Hour Replacement, Intensive Integration, Leveling,* and *Preparation,* ranging from $r = 0.195$ (*Intensive Integration*) to $r = 0.379$ (*Leveling*). The highest correlation within the integration factors was the strong relationship between *Intensive Integration* and *Leveling*. The other relationships within the integration factors were with the factor of *Preparation*, which had a moderate relationship with the factor of *Hour Replacement*, and a weak relationship with the factor of *Leveling*.

One of the purposes of this study was to explore any relationships between the adoption and integration factors. There were correlations significant at the 0.05 level between eight of the nine adoption factors and four of the five integration factors. The adoption factor of *Trustworthiness* did not correlate with any of the integration factors, and the integration factor of *Benchmarking* did not correlated with any of the adoption factors. No single adoption factor significantly correlated with more than two integration factors. The relationships between the adoption and integration factors were weak to moderate in strength.

The adoption factor of *Worldbuilding* had moderate relationships with the integration factors of *Intensive Integration* and *Leveling*. The adoption factor of *Pedagogy* had a moderate relationship with the integration factor of *Leveling*. The adoption factor of *Differentiation* had a moderate relationship with the integration factor of *Leveling*, and a weak relationship with the integration factor of *Intensive Integration*. The adoption factor of *Encouragement* had a moderate relationship with the integration factor of *Hour Replacement*, and a weak relationship with the integration factor of *Leveling*. The adoption factor of *Clarity* had a moderate relationship with the integration factor of *Intensive Integration*, and a weak relationship with the integration factor of *Leveling*. The adoption factor of *Evaluation* had a moderate relationship with the integration factor of *Intensive Integration*. The adoption factor of *Administrative Pressure* had a moderate relationship with the integration factor of *Preparation*. The adoption factor of *Visibility* had a moderate relationship with the integration factor of *Leveling*, and a weak relationship with the integration factor of *Preparation*. The integration factor of *Leveling* had the highest number of correlations with adoption factors; the only the adoption factors *Leveling* did not correlate to were those of *Trustworthiness* (which did not correlated with any integration factors) and *Administrative Pressure*.

4. Discussion

Existing research on virtual patient simulations in nursing education has focused on the efficacy of the modality or barriers to implementation rather than exploring the ways in which virtual patient simulation are integrated into the curriculum (Cook & Triola, 2009; Tworek et al., 2013). Reasons for the adoption of a particular virtual patient program are rarely mentioned, and they are not associated with subsequent integration strategies employed. In order to identify the latent variables related to the adoption and integration of virtual patient simulations in nursing education, the validated Virtual Patient Adoption and Integration in Nursing (VPAIN) survey instrument was distributed to nurse educators who had in the past or were currently using computer-based, interactive, asynchronous virtual patients in their curriculum. The first research question of this study was answered through the pilot test and analysis of the VPAIN survey, which indicated that the instrument was a valid and mostly reliable measure of virtual patient adoption and integration.

4.1. Adoption factors

The second research question of this study was, what features do nurse educators consider to be important when choosing virtual patient simulation technology for their curriculum? The data collected with the VPAIN instrument were used to conduct EFA, which identified nine adoption factors (*Trustworthiness, Worldbuilding, Pedagogy, Differentiation, Encouragement, Clarity, Evaluation, Administrative Pressure*, and *Visibility*) explaining 55.6% of the variance in the data.

The 10 items within the *Trustworthiness* factor related to issues of confidence, usability, and an expectation that the program was accurate and appropriate for educators and their students. The items within this factor addressed the confidence in the developer of a virtual patient program experienced by the educator who chose to adopt it and the students who used it. Virtual patient simulations provide a safe environment to acquire knowledge or practice skills, but the same knowledge and skills will, eventually, directly affect patient safety and outcomes when applied with future patients. The *Trustworthiness* factor represented the dependability of the computer-based technology to provide suitable simulation experiences.

The factor of *Worldbuilding* was the largest and most complex, containing 14 items that related to fidelity, flexibility, control over the virtual patient, and the structure of the learning environment, describing an overall desire to exert control over a realistic and well-ordered virtual world. *Worldbuilding* was noteworthy because all seven of the VPAIN items within the conceptual domain of realism were contained within this single factor. But perhaps worthy of even more note was that the other items included in the factor related to adaptability, customization, and accessibility. Items describing the clarity of the learning environment's framework and instructions were also included in this factor. The clustering of items related to realism, customization, and structure within one factor was explicable, given that simulation is, at its core, an engineered environment and scenario designed to accurately represent explicit situations or cases relevant to an educator's learning objectives. *Worldbuilding* represented the creation, support, and control of a realistic and immersive digital world.

The 10 items within the *Pedagogy* factor related to the learning outcomes, curricular fit, and perceived learning opportunities of the virtual patient program. This factor described the learning opportunity provided to students. *Pedagogy* addressed the capability of students to demonstrate their knowledge and abilities within an activity that provided clear and effective learning objectives, as well as metrics for the assessment of those outcomes. This factor also addressed the curricular and programmatic fit of the virtual patient program and its content, and the evidence provided on the program's effectiveness. *Pedagogy* represented the relevance of the virtual patient's intended learning objectives and the confirmation of students' success in meeting them.

The 10 items within the *Differentiation* factor related to the characteristics of virtual patient technology that distinguish it from other simulation technologies, and the perceived value of the virtual patient by educators and students. This factor addressed the consistency and objectivity of an asynchronous, learner-controlled simulation experience, supplemental features included in the program, the ability to replace other more time-intensive simulations with virtual patient assignments, and the perceived value of the program by educators and their students. The factor of *Differentiation* represented the observed significance of the technological advantages virtual patient simulations presented in contrast to other simulation technologies.

The factor of *Encouragement* contained seven items related to issues of students' acceptance, curriculum committees' input, and the support of other staff within the department and through virtual patient program user groups. Five of the items in this factor were from the conceptual domain of external influence. These items described the reality for many educators, who do not make their adoption decisions in a vacuum, and where students are often vocal in their support or disapproval of educational technologies. This factor addressed one barrier to new simulation adoption cited in the literature, which is a perceived lack of support by educators (Akhtar-Danesh, Baxter, Valaitis, Stanyon, & Sproul, 2009; Howard et al., 2011; Jansen, Berry, Brenner, Johnson, & Larson, 2010). This factor addressed the support of peers and approval of students. *Encouragement* represented external support and reassurance.

The factor of *Clarity* contained seven items related to issues of insight, confidence, training and support materials, and the ability to review or try the program prior to adoption. This factor described the transparency of the virtual patient program and the availability of its support resources. The transparency described related to both the internal record of student performance provided by the program, and the availability to see a demonstration or complete a free trial. The impact of the ability to try a simulation technology prior to adoption was described by Miller and Bull (2013) in their qualitative study on nurse educators' adoption of high fidelity simulations, though it was described as a barrier because it was difficult for educators to gain access to the simulation equipment. While it is much easier to gain access to a trial of a virtual patient simulation, the need for insight into the mechanics and outcomes of the simulation appears to exist for both technologies. The issue of transparency within this factor also related to the confidence educators felt that the virtual patient developer would continue to improve the program, which may be due to the fact virtual patient technology is relatively new in nursing education, and may be viewed as being in its nascent stages of development. The factor of *Clarity* represented an observable virtual patient program.

The seven items within the *Evaluation* factor related to the assessment, grading, feedback, and results of the virtual patient program. This factor contained items relating to the validity and reliability of easy-to-grade results, the delivery of immediate and meaningful feedback to students by the program, the provision of an environment where students could adapt their thinking, and the replacement of other assessment activities. *Evaluation* represented use of the virtual patient simulations as a reliable assessment instrument.

The factor of *Administrative Pressure* contained three items related to the influence of department staff members and institutional administration in the adoption the virtual patient. The administrative influence contained within this factor included both direct input on the decision to adopt the virtual patient, and general pressure to use innovative technologies. This factor also included the influence wielded by other educators in the nursing program. The influence described by this factor differed from that described in the factor of *Encouragement* both in its source and its substance. While *Encouragement* related to peer support and student feedback, this factor related to administrative and institutional authority. A qualitative study of the adoption of high fidelity simulations by nurse educators also found that a significant theme emerged related to administrative influence, which the researchers named "Getting Political" (Miller & Bull, 2013). Although this theme described pressure by administrators to use the simulation technologies regularly after adoption in order to justify the high cost of purchasing the equipment, this demonstrates that for some educators administrative and institutional authority affect both their adoption and their integration of simulation technologies. *Administrative Pressure* represented direct and significant external influence.

The three items within the *Visibility* factor related to issues of awareness of the virtual patient program. This factor described less direct exposure than the trial and personal demonstration included in the factor of *Clarity*. The items in the factor of *Visibility* included a demonstration viewed at a professional conference, word of mouth, and an unawareness of the other virtual patients available for comparison. *Visibility* represented awareness of the virtual patient program.

4.2. Integration factors

The most cited educational benefits of virtual patient simulations in nursing education are the development of clinical reasoning skills, increased diagnostic knowledge, repeatable scenarios, asynchronous use, and improved confidence (Forsberg, Georg, Ziegert, & Fors, 2011; Kiegaldie & White, 2006; R. A.; Lewis, 2009; Mancuso-Murphy, 2007). However, existing research has not explored the variety of ways in which virtual patient simulations are integrated by nurse educators to leverage these benefits. To address this deficit in the literature, the third research question of this study was, how are nurse educators integrating their adopted virtual patient simulation into their curriculum? This question sought to identify discrete behaviors associated with the implementation of virtual patient technology in nursing programs. The EFA identified five integration factors (*Hour Replacement, Intensive Integration, Leveling, Preparation,* and *Benchmarking*), which explained 53.3% of the total variance.

The four items within the factor of *Hour Replacement* related to using ungraded time spent with the virtual patient as a substitute for lab, clinical, or practicum hours. This factor is particularly meaningful in light of the recently published national longitudinal study for the National Council of State Boards of Nursing that found either no significant difference or a significant positive improvement between students in traditional clinical placements, and those students with either 25% or 50% of their clinical hours replaced with simulation (Hayden et al., 2014). As more research explores the effectiveness and practical application of simulation technologies in nursing education, state boards of nursing will continue to increase the amount of clinical hours eligible for replacement by simulation. This is of particular importance because the replacement of clinical hours with virtual patient simulations also has the potential to help to alleviate the difficulty some nursing programs experience in finding or funding clinical placements for their students.

The factor of *Intensive Integration* contained five items related to a deep and more labor-intensive curricular integration of the virtual patient, with regular graded assignments and user-created worksheets and rubrics to assess targeted skills. This factor described an ability and desire by educators to adapt the virtual patient to their unique goals, and an investment of the time required to engage in the grading of regularly assigned virtual patient simulations. This factor addresses the difference between writing paper cases or designing standardized patient scenarios, in which educators can create the exact simulation they feel is relevant to their curriculum and to the patient population their students will encounter, and the adoption of a commercially developed simulation program, which can be used as a regularly graded assignment, but may need modifications or adaptations to achieve a nurse educator's specific learning objectives.

The factor of *Leveling* contained four items related to the use of the virtual patient to demonstrate progressively complex content, connect concepts, and assess proficiency. This factor described the use of the virtual patient program as illustration for the purpose of connecting concepts from other courses or content areas, a tool to introduce increasingly difficult principles, or as a summative assessment to establish proficiency at the end of the semester. The concept of demonstration is particularly well-suited to asynchronous virtual patient simulations, which can be assigned to students, and then used again either in the classroom or as a repeated assignment to exhibit or allow for the practice of more advanced techniques or skills.

The four items within the *Preparation* factor related to the use of the virtual patient as a pass/fail activity to teach content or practice concepts prior to lecture, classroom activities, or lab hours. This factor described the assignment of the virtual patient before students attended lecture or lab activities as a way to introduce concepts, to provide a common point of reference for an in-class activity, or to ensure students' readiness for expensive lab time. *Preparation* is arguably the most basic integration strategy among the identified factors, due to the limited affect the virtual patient simulations have on the pedagogy of the course and the simple pass/fail assessment of student performance. While this factor does leverage the objective nature of asynchronous virtual patients, students could gain greater benefits from the application of new skills and knowledge in a virtual patient simulation following a lecture or other content delivery. Students who fund the virtual patient program may also find less value in a virtual patient program when their effort is graded only as pass/fail if it is also given minimal academic weight in the course grade, or if educators do not provide substantive feedback with their pass/fail assessment.

The factor of *Benchmarking* contained two items related to the use of the virtual patient as a formative assessment during the course, and to reinforce content after delivery through lecture or lab. This factor described the use of the virtual patient to evaluate comprehension throughout the course of the semester.

4.3. Adoption and integration factor correlation

The fourth and final research question of this study was, is there a relationship between the important features of virtual patient simulations and curriculum integration methods used? This question was answered by using the factors identified through EFA for the adoption and integration subscales to conduct a correlation analysis.

There were significant correlations between eight of the nine adoption factors and four of the five integration factors. The adoption factor of *Trustworthiness* did not correlate with any of the integration factors, indicating that there was no relationship between dependability and integration. The integration factor of *Benchmarking* did not correlate with any of the adoption factors, indicating that there was no relationship between adoption and formative assessment, although *Benchmarking* was correlated with every other integration factor.

The adoption factor of *Worldbuilding* had relationships with the integration factors of *Intensive Integration* and *Leveling.* This indicates that a desire for control over a realistic world was related to time-intensive, adapted structure and the connection of complex concepts and the assessment of proficiency. Because the adoption factor of *Worldbuilding* contained items related to control and customization of the program, it follows that the integration factor of *Intensive Integration,* and its items related to adapted structure, would be correlated. For the integration factor of *Leveling,* the fidelity of the virtual patient may affect a nurse educator's confidence in its ability to communicate complex concepts. However, this relationship may also be explained by an educator's desire for control over the virtual environment because they plan to use it as a summative assessment for their students.

The adoption factor of *Pedagogy* was correlated with the integration factor of *Leveling*, which suggests that when the relevance of the virtual patient's intended learning objectives was influential in adoption, educators then had confidence that the virtual patient was appropriate to use as a demonstration of complex concepts and as an assessment of proficiency.

The adoption factor of *Differentiation* had relationships with the integration factors of *Intensive Integration* and *Leveling*, which indicates that when observed significance of the technological advantages of the virtual patient simulation was influential in adoption, nurse educators integrated the virtual patient using time-intensive, adapted structure and to demonstrate increasingly complex concepts and as a summative assessment. This relationship suggests that educators spend more time integrating and using the virtual patient for pedagogical or evaluation strategies of consequence when they are influenced by the unique advantages virtual patients have over other simulation technologies.

The adoption factor of *Encouragement* correlated with the integration factors of *Hour Replacement* and *Leveling*, suggesting that when nurse educators had the support of their peers and their students, they were more likely to use the virtual patient simulation to replace clinical hours and as a summative assessment. However, it is likely that it is the peer support that facilitates the use of the virtual patient as a replacement for clinical hours due to the impact on their nursing program administration and accreditation, and it is the acceptance of students that gives educators the increased confidence to use the virtual patient as a summative assessment.

The adoption factor of *Clarity* correlated with the integration factors of *Intensive Integration* and *Leveling*, indicating that, similar to the correlations with *Differentiation,* when the unique characteristics of insight, transparency and support provided for a virtual patient were influential in its adoption, educators integrated the virtual patient as a regular, graded assignment and created custom content to meet particular objectives, and to connect concepts and assess proficiency.

The adoption factor of *Evaluation* had relationships with the integration factors of *Intensive Integration* and *Leveling*, indicating that when the reliability of the virtual patient program as an assessment instrument was influential, educators integrated the virtual patient with time-intensive grading and adapted structure, and for the connection of complex concepts and the assessment of proficiency. This relationship is logical, given that all three factors are related to the assessment of the virtual patient.

The adoption factor of *Administrative Pressure* had a relationship with the integration factor of *Preparation*, suggesting that when external pressure was the source of influence in adoption, the virtual patient was used as a pass/fail activity to teach content or practice concepts prior to lecture, classroom activities, or lab hours. As discussed in the inter-adoption factor correlations, *Administrative Pressure* was negatively correlated with the adoption factor of *Trustworthiness,* which indicates that the dependability of the virtual patient is not important for nurse educators who are directed to use the virtual patient by their institution or administrators. The use of the virtual patient as *Preparation* by educators who experienced *Administrative Pressure* could be due to the fact that they already intended to integrate the virtual patient as a low-stakes, pass/fail activity, when they were influenced by *Administrative Pressure* to adopt the technology. However, the use of virtual patient for *Preparation* could also be related to the negative correlation between the *Administrative Pressure* and *Trustworthiness,* and educators used the virtual patient for *Preparation* because they did not trust that the program was dependable.

The adoption factor of *Visibility* had relationships with the integration factors of *Leveling* and *Preparation,* which suggested that when awareness of the virtual patient program was significant in the decision to adopt, the virtual patient was used to connect concepts and assess proficiency, and to prepare for in-class activities and labs. Because *Visibility* also relates to the unawareness of other virtual patient programs at the time of adoption, this could mean that the educators did not investigate the field of virtual patient technology prior to adoption, and as a result do not feel confident that the program is worth the investment of time for *Intensive Integration,* or that it is appropriate for *Hour Replacement.*

The integration factor of *Leveling* had the highest number of correlations with adoption factors; the only the adoption factors that *Leveling* did not correlate to were those of *Trustworthiness* (which did not correlate with any integration factors) and *Administrative Pressure*. These correlations may indicate that *Leveling* is an integration strategy that is relevant to virtual patients as a whole, perhaps due to the unique advantages of the simulation technology.

4.4. Limitations and delimitations

This study was subject to several limitations. In the development of the VPAIN survey instrument, the interviews conducted and subsequent coding of transcripts may have been affected by researcher bias. In the construction of the final VPAIN survey within Qualtrics, a scale error existed in the third and final matrix of the integration subscale, omitting the fifth Likert-type option of "Always." This error resulted in the last seven items of the VPAIN survey (those within the conceptual domain of management) offering only a 4-point Likert-type scale including never, rarely, sometimes, and often as response options. Although regression scores were used for the factors scores in the correlation analysis, this error affected participants' ability to provide answers on the same scale as the first two integration matrices. Another limitation of this study included its unequal population sample. While BSN, RN-to-BSN, and MSN educators were well represented, fewer ADN and LPN/LVN educators participated, and even fewer nursing doctoral program educators participated. This unbalanced population sample may indicate that fewer of the nurse educators in these programs use virtual patient simulations in their curriculum, although it may also affect the generalizability of this study to all nursing education programs. Another limitation of the population sampling was the possible effect that non-probability sampling techniques may have had on the sample size criteria for the EFA. Because the population of nurse educators who had used virtual patient simulations was unknown, a random sample of the population could not be selected. However, by distributing the VPAIN instrument to the users of two of the major virtual patient providers, posting targeted ads on social networking sites, and recruiting through user forums, the researchers had confidence that the sample size criteria outlined by Mundfrom et al. (2005) was appropriate to determine the necessary sample size for the EFA. Another major consideration is the survey burden experienced by the participants in the present research study. The survey included more than 90 individual items, which may have impacted the way in which the participants responded.

A significant limitation of this study was the poor reliability for the integration factors identified. The Cronbach's alphas for the integration subscale ranged from $\alpha = 0.471$ (*Intensive Integration*) to $\alpha = 0.689$ (*Hour Replacement*). Three of the five integration factors fell below the level of 0.6 recommended for a new scale: *Intensive Integration* ($\alpha = 0.471$), *Preparation* ($\alpha = 0.558$), and *Benchmarking* ($\alpha = 0.521$). This poor reliability indicates that the items may not be suitable measurements of the factor in which they are included. However, due to the strength of many of integration factor loadings, the conceptual fit of the items with their factors, and the exploratory nature of this study, items with low or negative factor loadings were not removed in order to increase the Cronbach's alpha of these factors.

A delimitation of this study was the restriction of the population to nurse educators who were decision makers in the adoption of virtual patient integration. Of the 334 nurse educators who were currently using or had previously used virtual patient simulations, 194 were involved with the decision to adopt the technology. This excluded 42% of the survey respondents from participation in the full VPAIN instrument. This exclusion was made in order to measure the decision of adoption, and how that decision affected subsequent integration, but it also limits the generalizability of the integration behavior to those who choose to adopt the virtual patient program. Another delimitation is the selection of the field of nursing education. This decision limits this study's generalizability to health professions educators outside of the field of nursing. The use of a closed, Likert-type scale for the VPAIN survey limited the responses of participants to the options provided, and did not allow for any open-ended feedback on their experiences. This decision was made to facilitate the quantitative evaluation of the data. Another delimitation of this study was the convenience sampling of the subject matter experts interviewed in the development of the VPAIN instrument. Nurse educators who were currently using, or had previously used the Shadow Health virtual patient program were interviewed, and participated in the cognitive interviews of the pilot test of the instrument. Although many of the educators had used other virtual patients in addition to the Shadow Health Digital Clinical Experience, this may have affected the development of the adoption and integration subscales. Another delimitation related to this convenience sampling was that no educators interviewed during the development or pilot of the VPAIN survey were currently teaching in a two-year program (e.g., LPN/LVN, ADN).

4.5. Recommendations

There are several areas for which specific recommendations are warranted: practical applications for nurse educators, practical applications for nursing program administrators, and suggestions for future research.

The results and implications of this study should be used to help nurse educators conceptualize the constructs of adoption and integration of virtual patient simulations. By better understanding these processes, more informed decisions might be made. Using the adoption and integration factors identified, and their relationships described above, nurse educators can understand the variety of virtual patient features and integration strategies available, and then select virtual patients that best meet their needs and the needs of their students. Some nurse educators consider the implementation of simulation a challenging and unfamiliar pedagogy, which can prevent intentional integration (Griffin-Sobel et al., 2010; de Hrussoczy-Wirth, 2010). These educators should use the integration factors identified in this study to choose strategies that address their current or intended curricular structure. Virtual patient simulations can be integrated in a variety of ways, but nurse educators should clearly define the strategy, relationship, and management decisions they will make in order to intentionally and successfully implement the adopted program, since purposeful integration will address the cited negative effects on learning outcomes that result from the lack of purposeful and unsystematic assignment of simulations (Clapper, 2011; Harder, 2009).

Specifically, nurse educators who teach face-to-face, traditional length courses should evaluate potential virtual patient programs with the knowledge that the simulations could be used for *Hour Replacement*. Similarly, educators who teach online, accelerated courses should make their adoption decision acknowledging that they may need to invest the time for *Intensive Integration* of the virtual patient program. Educators who teach in baccalaureate and graduate nursing programs should consider their intended learning outcomes when adopting a virtual patient, as these programs are also more likely to involve *Intensive Integration*. Educators who are influenced by *Administrative Pressure* in their adoption decision should also seek the *Encouragement* of internal and external peers during the integration process, since these factors are often correlated, and this support would facilitate more effective and appropriate uses of the virtual patient such as *Hour Replacement* or *Leveling*, rather than restricting the use of the simulations to *Preparation*.

Administrators in nursing programs should also use the factors identified and their relationships to help conceptualize the adoption and integration of virtual patient simulations. Administrators should also take note of the implications associated with the adoption factors of *Administrative Pressure* and *Encouragement.* While *Administrative Pressure* may be unavoidable, and *Encouragement* cannot be compulsory, if administrative influence cannot be wielded with caution, a better understanding of these factors could still allow them to devote additional resources and support to the integration process in order to better meet identified learning outcomes outside of *Preparation*. Administrators should recognize that integration is a process rather than a point-in-time decision, and that it may take several semesters for nurse educators to become comfortable with the technology or to identify the best integration strategies for their needs. Because strategies like *Intensive Integration* in particular are more likely among educators who have been using a virtual patient program for more than four semesters, program evaluations of virtual patient simulations should also be conducted either more than once, or once over the course of three years. Another recommendation for administrators is to be sensitive to the variety of needs that educators may be trying to address, and, when possible, to facilitate flexibility for educators who are evaluating and selecting virtual patient simulations to meet them.

Future research on the adoption and integration of virtual patient simulations should be conducted using the VPAIN survey instrument. This will allow for the correction of the scale error that occurred in this study, and provide the opportunity to conduct confirmatory factor analysis. The conceptual framework for virtual patient integration that emerged during this study should be further investigated and expanded, as with increased adoption of virtual patient simulations, integration behavior may become more well-defined, more diverse, or both. Future research should pay particular attention to the effects of the number of semesters of use on integration behavior, as this could help to inform instructional designers, nurse educators, and virtual patient providers to integrate virtual patients more efficiently early in the first semesters of use.

5. Conclusion

The study of technology integration in K-12 classrooms has been described as a rapidly-moving target (Ritzhaupt, Dawson, & Cavanaugh, 2012). The same can safely be said for technology in higher education. This study served to provide an initial benchmark of current behaviors by developing a validated and reliable instrument to measure the adoption and integration of virtual patient simulations in nursing education. The VPAIN survey, with improvements, could be used to measure the changing trends in virtual patient adoption and integration in nursing. This study identified nine adoption factors and five integration factors that could be further explored, confirmed, or revised, and relationships between educator demographics and these factors were identified. Correlation analysis was conducted on the identified factors to explore the relationships between adoption and integration, which could also be studied further as the adoption of asynchronous computer-based virtual patients increases and as additional technologies are introduced and adapted to meet emerging needs in nursing education.

Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.compedu.2017.01.005

Appendix A

VPAIN survey instrument

The following items are virtual patient characteristics and situational variables that may have been influential in your evaluation and selection of a virtual patient program.

If you are using a virtual patient program in several nursing courses, please select responses that apply to the first course for which you adopted the virtual patient.

1. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s).

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The variety of virtual patient cases included in the program
b) The inclusion of varying levels of complexity among the virtual patient cases
c) The means by which users communicated with and manipulated the virtual patient
d) The level of learner engagement when interacting with the virtual patient
e) The realism of the virtual patient avatar (e.g., art, sound, dialogue, setting)
f) The variety of questions a student could ask the virtual patient
g) The number of responses the virtual patient could provide

2. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The consistency of the virtual patient experience
b) The ability to reference a common virtual patient case with all students
c) The virtual patient program's flexibility of application
d) The ability to use the virtual patient program with learners of varying levels of knowledge and experience
e) The capability for students to demonstrate their skills, knowledge, and ability to strategically navigate a situation through the virtual patient program
f) The virtual patient program was learner-controlled and self-paced
g) The virtual patient program was constantly available for students to use at any time of day
h) The virtual patient program offered supplemental features or activities outside of the simulation environment

3. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The virtual patient could save time by replacing the need to write cases and run simulations
b) The virtual patient could replace the grading of video recordings
c) The virtual patient program gave immediate and meaningful feedback to students
d) The virtual patient program provided valid and reliable results
e) The virtual patient program provided easy-to-grade results
f) The virtual patient program provided a detailed record of students' performance
g) The virtual patient program offered insight into students' critical thinking

4. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) Your perceived value of the program's cost and quality
b) The value perceived by your tech-savvy students
c) Your confidence that the virtual patient program would continue to improve over time
d) Your perception that the virtual patient provider was receptive to your feedback

5. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The virtual patient program applied the theories and concepts taught in your current curriculum
b) The virtual patient program applied the skills taught in your current curriculum
c) The virtual patient program demonstrated frequently encountered diagnoses
d) The virtual patient program's outcomes matched your learning objectives
e) The virtual patient program met the needs of your academic program
f) The virtual patient program could be used with you and your students' current computer hardware
g) The program was delivered via multiple modalities (e.g., laptops, tablets, mobile phones)

6. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The virtual patient's content was accurate
b) The virtual patient modeled good nursing techniques
c) You had the ability customize the virtual patient caseskk) You were able to control the virtual patient program by turning features on and off
d) The time commitment required by the virtual patient assignments was appropriate for your students
e) The virtual patient program could replace other components of your course
f) The virtual patient program provided a safe environment where students could make mistakes and build confidence
g) The virtual patient program provided a realistic clinical environment where students could adapt their thinking

7. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The ease with which the program could be downloaded or run
b) The ease with which the virtual patient program could be integrated into your curriculum without modifications
c) The effort required to learn how to use the virtual patient program was manageable for you and for your students
d) The virtual patient program used a recognizable pedagogical framework
e) The clarity and usefulness of the program's objectives and directions
f) The overall organization of the virtual patient program

8. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The virtual patient program had few technical problems
b) The program's technical support team was easily accessible and helpful
c) Training was provided to faculty
d) Resources and support materials were provided to students

9. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) You saw a demonstration of the program at a professional conference
b) You saw a personal demonstration of the program
c) You had the opportunity to test the program prior to adoption
d) The program offered a free trial

10. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) Evidence was provided on the program's effectiveness
b) The program provided metrics for the assessment of learning outcomes
c) The program provided observable and clear outcomes
d) The program provided a perceived learning opportunity for your students
e) The benefits of the program were clear to your students
f) Students embraced the virtual patient technology
g) You heard about the program from others

h) You were less familiar with the other virtual patient programs available

11. *Matrix:* Please indicate HOW IMPORTANT to you each factor below was in your DECISION TO ADOPT virtual patient software for your course(s). (continued)

Options: Not at all Important; Slightly Important; Somewhat Important; Very Important; Extremely

a) The pressure you received from other faculty in your program
b) The administrative or institutional pressure you received to innovate
c) The administrative input on the decision
d) A curriculum committee's input on the decision
e) The program's ability to relieve issues caused by the attrition of faculty and administrators in your program
f) All faculty were willing to use the virtual patient program
g) The existence of a champion faculty who acted as a liaison with the virtual patient program provider
h) The availability of user groups and forums dedicated to faculty who used the virtual patient program

The following items describe ways in which you may have integrated the virtual patient program after your decision to adopt it into your curriculum.

If you have been using a virtual patient program for several semesters, please select responses that apply to the most recent semester in which you used the program.

12. *Matrix:* Please indicate HOW OFTEN you have done the following.

Options: Never; Rarely; Sometimes; Often; Always

a) Assigned the virtual patient as an activity with no enforced order within the other activities of an asynchronous module
b) Assigned the virtual patient as an activity to teach content prior to your lecture, lab, or video instruction
c) Used the virtual patient as a live, synchronous activity in your classroom or lab to demonstrate concepts
d) Assigned the virtual patient after your lecture, lab, or video instruction to reinforce concepts taught
e) Assigned the virtual patient as a low stakes, formative assessment to monitor or benchmark your students' current skills and abilities at the beginning or during your course
f) Assigned the virtual patient as a summative assessment instrument to evaluate your students' proficiency at the conclusion of your course
g) Assigned the virtual patient to assess a single targeted skill (e.g., clinical reasoning, documentation, or physical assessment techniques)

13. *Matrix:* Please indicate HOW OFTEN you have done the following.

Options: Never; Rarely; Sometimes; Often; Always

a) Used time spent with the virtual patient to replace clinical hours
b) Used time spent with the virtual patient to replace practicum hours
c) Used time spent with the virtual patient to replace lab hours
d) Assigned the virtual patient as practice to prepare for labs or off-site clinical placements
e) Assigned the virtual patient as preparation for class activities (e.g., referring to students' documentation in a group discussion on documentation practices)
f) Used the virtual patient to apply concepts from other classes to connect content from one course to another
g) Used the virtual patient to demonstrate increasingly complex concepts

14. *Matrix:* Please indicate HOW OFTEN you have done the following.

Options: Never; Rarely; Sometimes; Often; Always

a) Assigned the virtual patient as a regular activity (e.g., weekly)
b) Created a grading rubric to assess outcomes not directly measured within the virtual patient program
c) Created new student worksheets or guides for a virtual patient assignment to achieve particular outcomes
d) Used the virtual patient as a way to communicate teachable moments to your students
e) Graded a virtual patient assignment with a letter or numerical grade
f) Graded a virtual patient assignment as pass/fail, without assigning a letter or numerical grade
g) Provided only feedback for a virtual patient assignment, without assigning a grade

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.compedu.2017.01.005.

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