Title
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Journal
Nurse Education Today, 35(1)

ISSN
0260-6917

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Publication Date
2015

DOI
10.1016/j.nedt.2014.05.013

Peer reviewed

Nurse Education Today 35 (2015) 63–67

Contents lists available at ScienceDirect

Nurse Education Today

journal homepage: www.elsevier.com/nedt

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ARTICLE INFO

Article history:
Accepted 27 May 2014

Keywords:
Learning style
Prelicensure
Nursing students
Human patient simulation

SUMMARY

Introduction: Human patient simulation (HPS) is a widely used method of teaching in nursing education. While it is believed that a student's learning style impacts knowledge gains in HPS, there is little evidence to support this. This study sought to determine the impact of learning style on knowledge gains after a heart failure (HF) simulation experience in pre-licensure nursing students.

Methods: A convenience sample of four cohorts of prelicensure nursing students ($n = 161$) were recruited from three Baccalaureate Schools of Nursing at the same point in their curriculum (age 25.7 ±6.6 years; gender = 85.5% female) and participated in HPS using a HF simulation on a high-fidelity manikin. Learning style was assessed by the Kolb Learning Style Inventory (LSI) and pre- and post-HPS knowledge measured by parallel, validated, knowledge tests. The LSI identifies 4 learning styles, (Assimilating Diverging, Accommodating, and Converging). In some cases, learners present a balanced learning profile—an emphasis of all four equally. Statistical analysis consisted of *t*-tests and ANOVA.

Results: HF knowledge scores post-HPS compared to pre-HPS scores revealed a mean improvement of 7 points ($p < 0.001$) showing evidence of learning. Within group score increases between the pre-test and post-test were seen for the Assimilating (66.68 ± 20.87 to 83.35 ± 12.59; $p = 0.07$), Diverging (61.95 ± 11.08 to 69.86 ± 12.33; $p < 0.01$) and balanced profiles (64.4 ± 12.45 to 71.8 ± 10.14; $p < 0.01$), but not for Converging or Accommodating profiles (73% of sample). Post-hoc paired *t*-tests revealed a large effect size for the Assimilators (0.91) and moderate effect sizes for both the Divergers and balanced profiles (0.67 and 0.65, respectively).

Conclusion: These findings confirm that knowledge gains occur with HPS and provide evidence that HPS is an effective teaching methodology for nursing students identifying with most types of learning styles.

Introduction

Internationally, human patient simulation (HPS) has become a common teaching methodology for nurse training. While some investigators have reported knowledge gains using HPS (Alinier et al., 2006; Brannan et al., 2008a; Jeffries and Rizzolo, 2006; Kardong-Edgren et al., 2009; Linden, 2008; Ravert, 2004; Shinnick and Woo, 2012; Shinnick et al., 2011), nursing has adopted this new teaching methodology without determining its effectiveness among the different learning styles of nursing students.

Background

Learning style is a propensity to a particular way of learning. Cognizance of learning style is important for educators as students learn in different ways yet many instructors teach using only one method (i.e., lecture). For example, some students may learn better with concrete, experiential type of educational experiences (HPS or hospital internships) while others prefer reflective types of learning opportunities, such as discussion (debriefing) or case study. Therefore, a single teaching modality may not be best suited for all nursing students at all stages of their education. Even in the nursing profession, learning styles have been shown to change with level of education attained, time since formal education and amount of professional experience (Robinson et al., 2012).

There are several instruments available to determine learning style preference. They include the Learning Style Questionnaire by Honey and Mumford, the Dunn and Dunn Learning Style Questionnaire, the Myers-Briggs Type Indicator, the Gregorc Style Delineator and the Learning Style Inventory (LSI) by Kolb. The Kolb LSI is a well-validated and reliable assessment instrument and often used in nursing studies (Cavanagh et al., 1995; Laschinger, 1986, 1992; Laschinger and Boss, 1984; Lockie et al., 2013; O'Kell, 1988; Ostmoe et al., 1984; Remington and Kroll, 1990; Shinnick and Woo, 2011; Sulliman, 2006; Sutcliffe, 1993; Washington et al., 1990). Therefore, it was chosen for this study.

☆ This study was funded by a grant from Sigma Theta Tau, Gamma Tau Chapter, University of California at Los Angeles.

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http://dx.doi.org/10.1016/j.nedt.2014.05.013
0260-6917/

Learning Style Most Common to Nurses

While learning style assessments vary, most recognize learners as active or concrete, reflective, theoretical, or intuitive. According to the LSI authors (Kolb, 1999, 2000), the learning style most aligned with nursing as a career is the concrete style, labeled the Accommodator in the LSI (Kolb, 1999, 2000). This has been substantiated by other researchers with nursing students using the LSI which found the samples to also be predominately Accomodator or Diverger learners (concrete) (Cavanagh et al., 1995; Laschinger, 1992; Remington and Kroll, 1990). Some surmise nursing students alter their learning style to the delivery of learning method but research in this area has been inconclusive (Cavanagh and Coffin, 1994). Unfortunately, most published research on the learning style of nursing students is decades old and hence is difficult to apply to the students of today.

Impact of Learning Style in Human Patient Simulation

Exploring the relationship of learning style and HPS has just begun in nursing with researchers looking at the correlation of learning style and critical thinking disposition (Vivien et al., 2010) and the correlation of learning style to student satisfaction (Fountain and Alfred, 2009). While learning theories have been used in the design of HPS training for nurses (Alinier et al., 2004; Feingold et al., 2004; Lasater, 2007; Reilly and Spratt, 2007), there are no publications on the impact of HPS on nursing students' knowledge with a diversity of learning styles. Therefore, this study sought to establish the impact of learning style on knowledge gains after a heart failure (HF) HPS experience in prelicensure nursing students.

Methods

Using a comparative research design, a convenience sample of four cohorts of prelicensure nursing students ($n = 161$) were recruited from three Baccalaureate Schools of Nursing at the same point in their prelicensure nursing curriculum. All schools used the same simulation equipment (Sim Man® Laerdal Medical Corp., Wappinger Fall's, NY) and Institutional Review Board approval was obtained from all three schools prior to data collection and recruitment for the study. Power analyses indicated that a sample size of 78 subjects would allow detection of moderate (0.5) effect sizes on an *a priori* ANOVA at an alpha of 0.05 and with a power of 0.80 (Faul et al., 2007).

Inclusion criteria were undergraduate nursing students in the same course at each school that had successfully completed instruction in the care of the decompensated heart failure (HF) patient. This point in the prelicensure curriculum is the standard equivalent of a Medical Surgical Course, Level III, taken in many schools in the final year of a Baccalaureate nursing program. Exclusion criteria were students who either had HF or had family members with HF.

HPS Scenario Development

Three parallel simulation scenarios of clinical cases of acute decompensated HF were used in this study (Shinnick et al., 2011). The scenarios were identical to each other in design with the exception of the patient history and gender and were planned to last 12 min. Parallel simulations were necessary in order to decrease cross talk between participants and prevent scenario predictability among students. The design of the scenarios was to elicit basic nursing responses such as elevating the head of the bed for a dyspneic patient, applying a pulse oximeter and appropriate supplemental oxygen administration, identifying pulmonary edema on physical exam, choosing the priority medication from multiple physician orders (intravenous furosemide) and monitoring appropriate electrolytes in a patient receiving a diuretic.

Subjects participated in the heart failure HPS in cadres of five. The hands-on HPS component was done with students individually and there were no confederates. Reflective style debriefing as a group followed upon completion of the last member of the cadre (fifth HPS event of the group) and lasted approximately 20 min. One trained debriefer (faculty) facilitated debriefings at all of the sites.

Data Collection Instruments

Kolb Learning Style Inventory (LSI)

The LSI is a web-based questionnaire in which subjects rank order endings to presented sentences. Responses correspond to one of the 4 types of orientations to learning style (Assimilating, Diverging, Accommodating or Converging). In some cases, learners present a balanced learning profile—an emphasis of all four equally. The 12-item assessment takes less than 30 min to complete. This fee-for-service test is then analyzed by the Hay Group with results given to the researcher, and to the test-taker, if desired. The results also include a grid representation of each subject's learning style.

Types of Learning Styles

Kolb depicts learning styles as a cycle of 4 stages representing how learners interact with their environment. Concrete experience (CE) leads to reflective observation (RO) which then leads to concept formation or abstract conceptualization (AC) which is then used in decision making and problem solving ([active experimentation] AE). Scores on this assessment are plotted by emphasis on abstractness over concreteness (AC-CE) and that of action over reflection (AE-RO) with the results falling into one of four quadrants labeled Assimilator, Diverger, Accommodator and Converger (Fig. 1). An emphasis of all four equally is known as a balanced learning profile (Kolb, 1999, 2000).

Specific learning preference characteristics identify the type of learner on this instrument. One who has an *Assimilating* learning style has the ability to create theoretical models, use inductive reasoning and like abstract concepts such as science and math. They are less people-oriented and less practical than the other learner types and prefer reflection. These learners are considered abstract learners. The *Diverging* style learner is imaginative, has broad cultural interests, seeks information and tends to specialize in the arts and humanities. This learner is people-oriented, is able to look at problems from several perspectives and organize ideas together and is considered a concrete learner. The *Accommodating* type of learner is one who puts ideas into action, is intuitive and adapts well to changing circumstances and is considered a concrete learner. This type of learner is able to solve problems by using intuition and trial and error but does not collect their own data or make their own decisions. They do well in performing under the direction of others. A *Converging* learning style is characterized by a practical application of ideas, and hypothetical-deductive reasoning reflecting an abstract learner (Fig. 1). Learners may also present with a

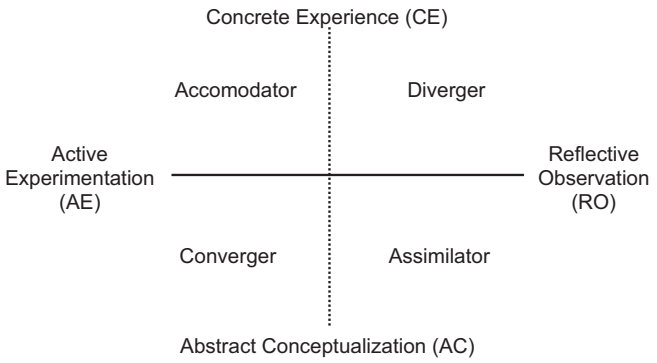

Fig. 1. Taxonomy of the Kolb Learning Style Inventory.

balanced learning profile which indicates an emphasis of all four modes equally.

Clinical Knowledge Questionnaire

Three parallel Clinical Knowledge Questionnaires were developed by the investigator based on National Guidelines for HF management (Jessup et al., 2009). Each version of the Clinical Knowledge Questionnaire was different but considered parallel (questions with the same intent) to the others. Each questionnaire consisted of 12 items with a maximum possible score of 12 points. The questions did not mention HF by name so the participant was blinded to the topic of the simulation. However, questions were included which focused on desired nursing interventions for common issues associated with HF, such as elevating the head of the bed and administering oxygen. Scoring of the HF Clinical Knowledge Tests was via Scantron®, an automated grading device. Validation of HF Knowledge Questionnaires was done by three experts in HF management (one cardiologist from a world-renowned HF clinic and two doctorally prepared nurses with HF expertise—none were co-investigators on this study). These experts in HF reviewed and provided content validity for the knowledge assessments with 100% agreement among the three experts. The questionnaire was pilot tested and used in another published study (Shinnick et al., 2011).

Demographic Questionnaire

A demographic questionnaire was given to each subject *after* participation in the HPS so as to not reveal the simulation topic. It included the participant's age, gender, ethnicity, school attending, history of personal or family experience with HF, and number of prior HPS exposures in their nursing program. No students met exclusion criteria so all were included in the study.

Data Collection Procedures

Two sequential full days were scheduled for data collection at each site within 3 weeks of their HF lecture. The study sequence was for the subjects to take the on-line LSI prior to the study day, the Clinical Knowledge Questionnaire on the study day before HPS (pre-test) and a parallel version of the Clinical Knowledge Questionnaire after HPS (post-test) (Fig. 2). A 2 GB flash drive was given as a thank you gift to all subjects.

Statistical Analyses

Statistical analyses were done using SPSS version 20 software (IBM Corp, Released 2011). *T*-tests were performed to determine changes within learning style groups pre- and post-HPS knowledge scores and ANOVA with post-hoc *T*-tests was used to determine impact of learning style on knowledge gains at post-test between groups.

Results

The variables were examined for accuracy and normality of distribution by reviewing data entry responses, fit between their distributions and assumptions examining histograms, normal probability plots of residuals and scatter diagrams of residuals versus predicted residuals. Data distribution was normal and no violations of normality, linearity or homoscedasticity of residuals were detected. In addition, box plots revealed no evidence of outliers. There were no differences between first or second degree (master's entry) students.

One hundred and sixty one (161) students in four cohorts, 3 different nursing schools, of generic baccalaureate and one cohort of master's entry nursing students completed the study with no students meeting exclusion criteria (students who either had HF or had family members with HF). Subjects were predominately female (85. 5%) with a mean

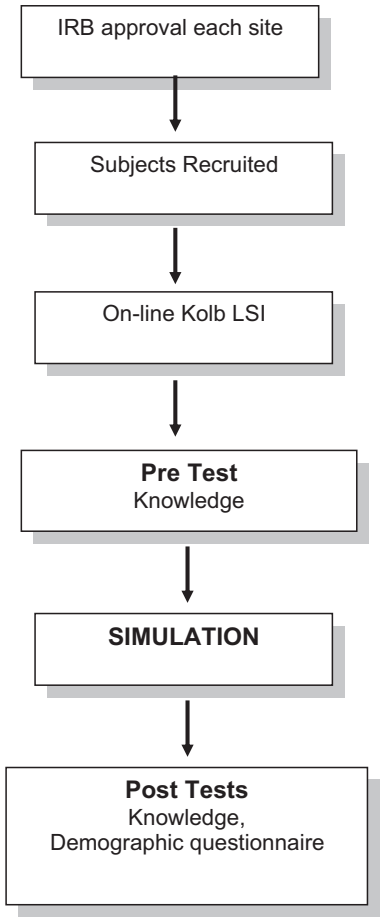

Fig. 2. Study protocol.

age of 25.7 (±6.6) years. The largest portion of the sample identified with a balanced learning profile (49.7%) while the remainder of the sample identified as having an Accommodating style (24.2%), Diverging style (18.6%), Assimilating (5%) or Converging (2.5%) style (Table 1). Mean scores on the HF Clinical Knowledge test for all subjects ($n = 161$) increased 7 points from the pre-test (64.43 ± 12.45) to the post-test (71.43 ± 12.29; $P < 0.01$) indicating significant knowledge gains overall (Fig. 3).

Knowledge Changes within Learning Style Groups

Statistically significant score increases were only seen between the pre-test and post-test for the Diverging and balanced learning style profiles (68.3% of total sample) (Table 1; Fig. 4).

Knowledge Differences between Learning Style Groups

Repeated measures ANOVA was done to determine significant knowledge gain differences between the learning style groups. Subjects with the Assimilating learning style (reflective thinkers) performed significantly better for post-test knowledge (83.35 ± 12.59) than subjects with a Diverging learning style (active thinker; post-test score 69.86 ± 12.33; $p = 0.04$) or Accommodating learning style (combination of active and reflective thinking; post-test score 69.69 ± 14.63; $p = 0.033$) (Table 2). However, on a post-hoc paired samples *t*-test, effect sizes on knowledge between groups revealed both Diverging (effect size 0.67 [medium]) and balanced learning styles (effect size 0.65 [medium]) or to be fairly effective. The only more effective learning style may be the Assimilating style with the highest effect size (0.91 [large]) but this group was the least represented (5% of sample).

Table 1
LSI results and knowledge score changes by learning style.

Learning style	*N*	Pre-test (mean/SD)	Post-test (mean/SD)	*P* value	Effect sizes
Assimilating	8 (5%)	66.68 (±20.87)	83.35 (±12.59)	0.07	0.91 (large)
Diverging	30 (18.6%)	61.95 (±11.08)	69.86 (±12.33)	<0.01*	0.67 (med)
Accommodating	39 (24.2%)	66.15 (±11.73)	69.69 (±14.653)	0.178	0.26 (small)
Converging	4 (2.5%)	62.5 (±10.76)	68.75 (±18.50)	0.392	0.38 (small)
Balanced	80 (49.7%)	64.4 (±12.45)	71.8 (±10.142)	<0.01*	0.65 (med)

* statistically significant at $p < .05$.

Conversely, effect sizes for Accommodating and Converging learning styles were small (0.26 and 0.38, respectively) (Table 1).

Discussion

In this study, subjects identified with primarily a balanced learning profile which is unlike the findings in other nursing studies. For example, one group found a predominance of nursing students ($n = 44$), identified with the Diverger learning style (Remington and Kroll, 1990) whereas Lockie et al. (2013) found the sample of 197 nursing students to be Assimilators and Cavanagh et al. (1995) ($n = 186$) did not find an obvious predominance of any one style. More consistent findings of learning style are seen in samples including practicing nurses as subjects. Several studies identified the nurses as predominantly concrete learners of Accommodating or Diverging learning styles (Cavanagh et al., 1995; Kolb, 1999, 2000; Laschinger, 1992; Remington and Kroll, 1990; Robinson et al., 2012). One reason for the variation between studies as well as between nurses and nursing students could be related to nursing student subjects not yet identifying with a preferred learning style as they are exposed to multiple methods of teaching in the college setting. Another explanation for most of the nursing students in this sample having a balanced learning profile could be related to the familiarity of the reflection strategies used in prelicensure nursing education such as journaling and as a part of HPS (debriefing). While one study (Mainemelis et al., 2002) found subjects with balanced profiles demonstrated more flexibility in adapting toward different learning styles, they had significantly less developed learning and analytical skills. These particular skills need to be learned and maximized in occupations that call for a specialized expertise such as nursing. Therefore, a balanced profile is not desired for practicing nurses as decisions may need to be made such that time for reflection is not always possible. However, it is likely that the remainder of the student nursing education of these subjects was able to provide the necessary learning and analytical skills for practice such that their learning preferences evolved.

Statistically significant knowledge gains occurred in the overall sample. This is consistent with other studies of knowledge gains in prelicensure nursing students after HPS (Brannan et al., 2008b; Hoffmann et al., 2007; Howard, 2007; Jeffries and Rizzolo, 2006; Ravert, 2002; Shinnick et al., 2011, 2012). However, HPS seems to have a greater effect on learning outcomes for students of particular learning styles. The post-hoc effect sizes were quite good (moderate to large) for those identifying with a Diverging, Assimilating or balanced learning profile. One explanation for this relates to the two components of HPS as a teaching methodology: the hands-on component (Divergers prefer active participation) and the debriefing component (Assimilators prefer reflection). Additionally, those with a balanced profile are able to use each learning profile emphasis equally and learn with HPS. The combination of different teaching methods in one delivery method (HPS) is appealing to both students and faculty. As these three learning styles accounted for 73% of the sample, faculty can be assured HPS will be effective as a teaching methodology for most prelicensure nursing students. However, it is not realistic to expect one teaching modality to be effective for all learners so consideration should be given to multimodal forms of instruction such that all learners have an opportunity for development.

This study measured knowledge after HPS among different student learning preferences and was able to provide evidence that it is an effective teaching methodology for those who identify as Assimilators or Divergers or who have a balanced learning profile (73% of sample). As students have varied learning styles, teaching requires diverse educational approaches at various levels of training (Gurpinar et al., 2010). This is good news as educators believe individuals use a mixture of different learning styles dependent upon the situation (Loo, 2004) and others (Laschinger and Boss, 1984) have stressed for decades the importance of including multiple types of learning activities alongside lecture so all learning styles can thrive. This is supported by Kolb who asserts that the key to effective learning is the ability to be flexibly competent in each mode when it is called for, but not to use all modes in every situation (A. Kolb & Kolb, 2005).

Conclusion

In conclusion, while many educators believe that teaching would be more successful if instructors recognized and addressed the different learning styles of their students (Chickering & Gamson, 1987; McKeachie, 1999; Sulliman, 2006), analyzing the different learning styles is not practical. As such, educators can confidently utilize HPS as

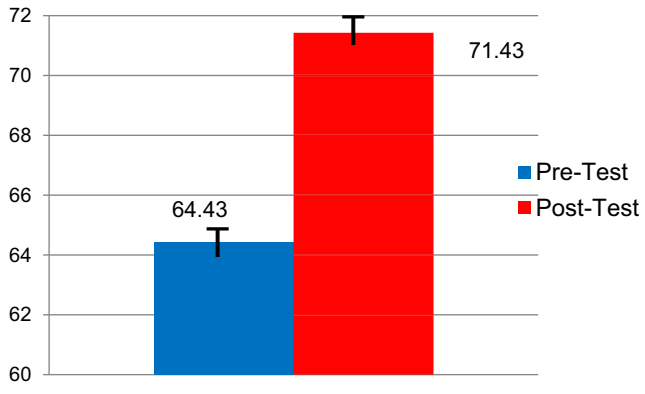

Fig. 3. Knowledge scores pre–post test all subjects ($n = 161$).

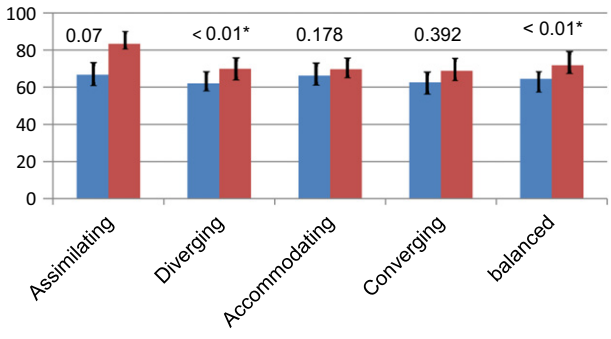

Fig. 4. Knowledge score changes between pre- and post-test for knowledge by learning style ($n = 161$). *Statistically significant $p < 0.01$.

Table 2
Differences between learning styles and post-test knowledge scores on ANOVA ($n = 161$).

Learning style	Mean score	SD	*P* value
Assimilating	83.35	±12.59	0.045*
Diverging	69.86	±12.33	
Assimilating	83.35	±12.59	0.033*
Accommodating	69.69	±14.63	
Assimilating	83.35	±12.59	0.284
Converging	68.75	±18.49	
Assimilating	83.35	±12.59	0.080
Balanced	71.80	±10.12	

Assimilating group scored significantly higher than both Diverging and Accommodating groups.
* Denotes statistical significance at the 0.05 level.

an adjunctive teaching method for today's technology driven students in order to blend theory and practice as knowledge gains will be achieved in prelicensure nursing students of different learning styles. This is especially important as HPS has become a popular teaching methodology desired by faculty and students alike. However, recommendations include research replication in different settings (i.e., lab and in situ) to validate these findings among other prelicensure nursing students as well as experienced nurses in multiple disciplines. Further HPS related research also needs to be done to determine the impact of student learning style preference in areas such as skill attainment, clinical judgment and patient safety.

Acknowledgments

The authors would like to acknowledge the following research assistants who volunteered their time and expertise to this study: Lorie Judson PhD, RN, Professor, School of Nursing, California State University at Los Angeles, Deborah Bennett, PhD-c, MN, RN, Faculty and Simulation Lab Coordinator, California State University at San Marcos, Angela Six, BSN, RN, Kulwant Dosanjh, MA, former Simulation Lab/Clinical Coordinator, University of California at Los Angeles, and Susan Morgan, BSN, RN, Assistant Simulation Lab Coordinator, California State University at San Marcos.

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