Clinical Simulation in Nursing (2015) 11, 507-512

Clinical Simulation in Nursing

www.elsevier.com/locate/ecsn

Featured Article

Development of an Instrument to Measure Nursing Student Teamwork Skills

Sherrill Smith, RN, PhD, CNL, CNE[a,*], Sharon Farra, RN, PhD, CNE[a], Raymond Ten Eyck, MD, MPH, FACEP[b], Marie Bashaw, RN, DNP, NEA-BC[a]

[a]*College of Nursing and Health, Wright State University, Dayton, OH 45435, USA*
[b]*Boonshoft School of Medicine, Wright State University, Dayton, OH 45435, USA*

KEYWORDS
nursing education;
teamwork skills;
instrument development;
interprofessional education;
research

Abstract

Background: The purpose of this project was to develop an instrument to measure nursing student teamwork skills in a simulated environment.

Method: An eight-step instrument development process was used that included literature review and evaluation of face/content validity and inter-rater reliability.

Results: Psychometric quantitative analysis of the final 11-item instrument included a scale content validity index of 0.98 and individual item content validity index scores ranging from 0.75 to 1.0 for the 11 items. Inter-rater reliability demonstrated consistency with interclass correlation coefficient of 0.836.

Conclusions: An eight-step process can be used by nurse educators to develop psychometrically sound instruments for use in student evaluation.

Cite this article:
Smith, S., Farra, S., Ten Eyck, R., & Bashaw, M. (2015, December). Development of an instrument to measure nursing student teamwork skills. *Clinical Simulation in Nursing, 11*(12), 507-512. http://dx.doi.org/10.1016/j.ecns.2015.10.006.

Despite the fact that nursing students are often evaluated as individuals in clinical settings, new nurse graduates are expected to function as a member of a team utilizing team-based skills to promote safe patient care (American Association of Colleges of Nursing, 2008). Valid and reliable instruments are needed for faculty to objectively evaluate and provide feedback to students to promote teamwork knowledge, skills, and attitudes. The purpose of this article was to describe a process for the development and evaluation of an instrument to measure nursing student team skills based on the TeamSTEPPS framework (Agency for Healthcare Research and Quality [AHRQ], 2015).

Background

Experienced health care professionals working in teams have demonstrated improved performance, increased satisfaction, and decreased errors after medical team training (Beitlich, 2015; Berkenstadt et al., 2008; Ellis et al., 2008;

* Corresponding author: sherrill.smith@wright.edu (S. Smith).

1876-1399/$ - see front matter
http://dx.doi.org/10.1016/j.ecns.2015.10.006

Morey et al., 2002; Shapiro, et al., 2004; Steinemann et al., 2011). Interprofessional education (IPE) for health care trainees, including undergraduate nursing students, provides increased understanding of other health care professional roles and raises expectations for team orientation in future workforce generations. One framework for offering IPE and teaching team-based operations skills is TeamSTEPPS (AHRQ, 2015). This evidence-based framework was developed specifically to address patient safety issues through improved communication and teamwork skills, including those at the front-line of patient care. The TeamSTEPPS framework is based on four team-based skills: leadership, communication, situation monitoring, and mutual support.

Key Points

- Standards of best practice for simulation assessment and evaluation specify the importance of using instruments with documented psychometric properties.
- An eight-step process for instrument development can be used to facilitate new instrument development.
- Interprofessional simulation activities provide opportunities for assessing and validating team-based skills to promote safe patient care.

Evaluation of nursing competencies has historically been accomplished using rubrics or checklists to objectively determine acceptable versus unacceptable student performance (Billings & Halstead, 2011). However, it has been noted that many of the rubrics used in nursing education lack appropriate psychometric properties to appropriately evaluate student performance (Adamson, Kardong-Edgren, & Wilhaus, 2013). In terms of evaluation of teamwork skills, a wide variety of assessment scales are available to assess clinical team performance in both simulated and actual patient care environments (Cooper et al., 2010; Fletcher et al., 2003; Guise et al., 2008; Hayden, Keegan, Kardong-Edgren, & Smiley, 2014; Kim, Neilipovitz, Cardinal, Chiu, & Clinch, 2006; Malec et al., 2007; Siassakos et al., 2011; Sigalet et al., 2013; Walker et al., 2011). Analyzing these tools, the authors felt that the available instruments were either too subjective or oriented to settings other than those fitting the unique needs of the local institution's interprofessional educational activities developed based on the TeamSTEPPS framework. A specific TeamSTEPPS tool, the Team Performance Observation Tool (AHRQ, 2015), was also evaluated and found to include an appropriate scope of behaviors assessing team skills. However, this tool only addresses general behaviors and not specific actions. In addition, it does not provide anchor descriptions to identify what actions are linked to each of the five different levels of performance for each item in the tool. Failing to find an evaluation instrument that met the needs of the researchers, an eight-step process was used to develop a new tool to address best practice standards for IPE education adhering to the guidance that educators must meet institutional and local needs (Decker et al., 2015). The newly developed tool incorporated the key team actions based on TeamSTEPPS. This article outlines the development of an instrument to measure nursing teamwork skills based on a pilot study analyzing the effects of a TeamSTEPPS Essentials® training course in an interprofessional simulation activity.

Instrument Development Framework

Simulation provides opportunities to practice and demonstrate competencies in a safe learning environment. A variety of competency checklists have been developed to evaluate nursing students in simulated settings (Jeffries, 2012). Any evaluation instrument used for assessing participants should be built on evidence-based content, clearly established scoring methods, and have demonstrated validity and reliability (Sando et al., 2013). To develop an instrument based on these best practice approaches to be used in evaluating effectiveness of a team-based teaching intervention, the eight steps identified by DeVellis (2003) were used as the framework for instrument development in this study. The eight steps of this framework are listed in Table 1.

Methods

Settings and Sample

Participants in the study were a convenience sample of senior baccalaureate nursing students in a medium-sized public university enrolled in a final capstone nursing course over two semesters (Fall 2014 and Spring 2015). Inclusion criteria were senior nursing students over the age of 18 years who voluntarily consented to be in the study. All 151 students agreed to be observed as part of the instrument study development process. There were no exclusion criteria except for those who were unwilling to provide consent to participate. Students who consented took part in a high-fidelity simulation experience at the university's School of Medicine simulation laboratory. Institutional review board approval was obtained from the affiliated university before conducting the study.

Procedures

A collaboration between nursing and medicine to develop an IPE simulation activity was initiated in 2012. As part of the activity, nursing students were given an abbreviated TeamSTEPPS Essentials® course involving a 1-hour interactive presentation addressing the challenges to medical team operations and the tools provided by TeamSTEPPS.

Table 1 DeVellis (2003): Eight-Step Instrument Development Process

Step	Action
1	Clearly determine what is to be measured: meeting with research team
2	Generate a pool of items: literature review and content experts
3	Decide on format for measurement: behavioral observation rubric
4	Review of initial item pool by experts: face validity by content experts
5	Validation of items: content validity appraisal and revision
6	Administer to development sample: pilot sample
7	Evaluate performance of individual items: inter-rater reliability assessment
8	Optimize length of scale: review of usability and item relevance

After the presentation, students were scheduled in groups of three to four students to work with an Emergency Medicine resident to practice teamwork skills in emergency department (ED)—based scenarios. In prior research, participants expressed high levels of satisfaction and intentions to incorporate TeamSTEPPS principles into practice after the presentation (Ten Eyck & Smith, 2013). However, performance in the simulation laboratory did not seem to consistently confirm success in achieving those intentions. The logical next step was to quantitatively evaluate if performance in simulation based on the training did reflect TeamSTEPPS principles.

This lead to the first *step* of the framework by DeVellis (2003)—clearly describes what is to be measured. Nursing and medicine stakeholders met to determine a clear purpose of what behaviors were to be measured by the instrument to help evaluate student outcomes in an interprofessional simulation experience. In this step, the researchers evaluated a variety of available teamwork instruments employing different concepts and scoring criteria. Because no instruments were found that specifically satisfied the simulation experience objectives, the researchers agreed to develop an instrument focused on the four teamwork skills identified by the TeamSTEPPS framework.

In *Step 2*, one of the researchers reviewed the literature and the TeamSTEPPS literature to develop an initial pool of ten items to assess nursing student team operation skills in a simulated environment. This initial instrument was shared with the research team, and edits were made to create a product that included 11 behavioral items to ensure incorporation of all four categories of TeamSTEPPS skills.

As part of development of the item pool, the researchers also considered *Step 3*, determination of the measurement format. While reviewing the available instruments, a variety of scoring options and evaluation criteria were analyzed. The team decided to utilize an evaluation of each behavioral item based on one of three options (not met, partially met, or completely met).

For *Steps 4 and 5*, expert review and content validation of the instrument were conducted using nine nurse faculty with expertise in simulation and/or TeamSTEPPS knowledge. Reviewers rated each item of the proposed scale based on the item objective and behavioral statement in terms of relevance, clarity, simplicity, and level of ambiguity on a scale of 1-4 (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = very relevant). See Table 2 for sample Content Validity Index (CVI) scoring tool. A CVI was then calculated based on expert review scores. Based on reviewer feedback and results of CVI analysis, additional tool revisions were made to provide clarity and simplicity to the verbiage of each of the behavioral items. Revisions were made based on the initial CVI results with comments related to clarity, relevance, and simplicity made.

The revised instrument was then administered to a developmental sample, as required for *Step 6*. For this step, seven nurse faculty piloted the instrument evaluating two video scenarios created by the researchers that reflected varied use of teamwork skills. Additional revisions were made based on user feedback to further provide clarity and ease of usability.

Table 2 Content Validity Index Scoring Tool Example

Objective	Behavior	Relevance: 1 = Not Relevant, 2 = Somewhat Relevant, 3 = Quite Relevant, 4 = Very Relevant	Clarity: 1 = Not Clear, 2 = Somewhat Clear, 3 = Quite Clear, 4 = Very Clear	Simplicity: 1 = Not Simple, 2 = Somewhat Simple, 3 = Quite Simple, 4 = Very Simple	Ambiguity: 1 = Very Ambiguous, 2 = Somewhat Ambiguous, 3 = Unambiguous, 4 = Very Unambiguous
Accurately communicate with team members (Leadership)	Nurse team leader conducts a briefing.				
Comments:					

In *Step 7*, evaluation of the items, the resulting 11-item instrument was piloted by three nurse educators using the tool to evaluate two cohorts of senior baccalaureate nursing who took part in interprofessional ED–based simulation scenarios over two semesters at the university's School of Medicine Simulation Center. The three nursing faculty, who were different from the faculty used to conduct the CVI analysis and piloting of the instrument, were experienced in simulation and TeamSTEPPS knowledge and trained in use of the instrument. Using the new instrument, the three faculty reviewed videos of 38 simulation scenarios in which teams of three to four nursing students collaborated with an ED resident. The results were used to conduct an inter-rater reliability evaluation using interclass correlation. In *Step 8*, the researchers reviewed the overall tool including usability and item relevance.

Results

Demographics

Students from two cohorts taking part in the interprofessional simulation experience were all enrolled in a final semester capstone course over two consecutive semesters. In this capstone course, students were provided the opportunity to work one-on-one with a registered nurse preceptor to provide a culminating clinical experience for students as they prepared to graduate. In addition, they took part in 24 hours of simulation experiences, including this experience. Students were primarily female (90%), Caucasian (85%), and ranged in age from 21 to 46 years.

Content Validity

The CVI was calculated by recoding a rating of 1 or 2 as "0" and each rating of 3 or 4 as "1" for each item in terms of relevance, clarity, simplicity, and ambiguity. Initial mean CVI scores for each of the 11 items ranged from 0.55 to 0.94 based on the average of the reviewer's scores for that item, which were identified as be less than acceptable (Lynn, 1986). Edits to improve clarity and simplicity of items were made, and a second analysis resulted in a range of item CVI scores of 0.75-1.0. The overall instrument CVI was found to be 0.98. In addition to rating items, reviewers provided comments to improve the usability of the instrument. Minimal changes were made on the basis of comments from the second CVI review, mostly in terms of language to clearly reflect criteria for each anchor for each item.

Inter-rater Reliability

A total of 38 pairs of observations from two semesters were used to calculate inter-rater reliability using intraclass correlation (ICC). ICC assesses rating reliability by comparing the variability of different ratings of the same subject to the total variation across all ratings and all subjects. The ICC is calculated as the proportion of the total variance accounted for by within-subject variation. The model chosen for this ICC included different raters, averages of raters, and the use of absolute agreement (Shrout & Fleiss, 1979). The effects were set as semester (fixed effect), students (random effect), raters (random effect), and residuals (random effect). Computed within-subject correlation (ICC) was 0.56. At alpha = 0.05, a 95% confidence interval for ICC was found to be [0.325, 0.739]. ICC of 0.5-0.6 indicates moderate agreement between the raters. Rater-to-rater differences accounted for only 2% of the total variance. Unfortunately, residuals not explicitly modeled by any of the sources above accounted for 43% of total variation. Because the data did not contain multiple rates on each rater-by-subject combination, there was no way to further decompose the residual variance.

Discussion

The present study resulted in development of an instrument to measure nursing student teamwork skills based on the TeamSTEPPS framework using an eight-step process proposed by DeVellis (2003). Based on testing the instrument with two cohorts of students collected over two semesters, initial results indicate positive validity and reliability. The eight steps provided an orderly process for development of a psychometrically appropriate instrument. With nurse educators increasingly being asked to document outcomes, a similar process can be used by nurse educators interested in developing instruments for evaluation of outcome measures to implement best practices for assessment and evaluation of students, especially in simulated settings (Sando et al., 2013). The authors note, however, that development of this psychometrically acceptable instrument took over a year of work to refine and adapt the instrument to address anticipated outcomes of simulation. In addition, the work could not have been performed without an expert statistician to identify appropriate statistical measures and evaluation of statistical results. Nurse educators must have both time and appropriate support resources to implement a systematic development process required to generate tools that are both reliable and valid (Adamson et al., 2013).

The team-based nature of health care is now a given and requires the incorporation of interprofessional learning opportunities to promote safe, quality patient care. However, standards of best practice dictate that outcomes of any interprofessional activity must be observed and measured using reliable evaluation tools (Decker et al., 2015; Sando et al., 2013). The TeamSTEPPS framework used in developing the instrument in this study was found to best address the local institutional specifics for teamwork skill training. Others may find that this specific framework may not meet

local needs and find that another framework is better suited for training and evaluation of team-based knowledge, skills, and attitudes. The eight-step process described provides a means for developing evaluation tools for institution specific needs.

Limitations of the study are related to use of the instrument with students in one program of nursing with a sampling approach that limits generalizability beyond the current sample. Based on the findings, future studies applying the instrument to other interdisciplinary teams are needed. In addition, the observations of behavior were based on the performance in a simulated setting; teamwork performance in an actual clinical setting was not evaluated nor was it the intent of the instrument. However, only an evaluation of teamwork skills in a clinical setting would allow understanding of translation of lessons learned in the simulation to practice. Further research is also needed to identify appropriate scoring levels. If the tool is to be used for evaluation of competency of a skill, additional work is needed to identify scores for determining acceptable levels of competency, which was not accomplished with this initial work, but is needed to promote best practices of evaluation (Sando et al., 2013). Another limitation of the study was evaluation of inter-rater reliability. In theory, the residual variation could be further decomposed into student-by-rater interaction and pure error. But, for this data set, we could not distinguish them because there were no replicated ratings for each student-by-rater combination. In a future study, the raters could rerate each student again to evaluate the contribution of the student-by-rater interaction.

Conclusions

Preparation of tomorrow's workforce is the essence of nursing education. As nurse educators continue to uphold standards of best practice in nursing education, including the use of simulation, psychometrically appropriate instruments must be used to determine achievement of student outcomes to improve both individual student performance and document program effectiveness. The processes for instrument development that lead to tools that will provide needed outcome data, such as the process described by DeVellis (2003), are available to assist nurse educators. By validating student outcomes through psychometrically appropriate instruments, nurse educators can ensure that the educational forum is indeed preparing the nurses of tomorrow.

Acknowledgments

The authors would like to acknowledge the assistance of the faculty and students in the College of Nursing and Health for assisting with this study. The authors would also like to acknowledge the Emergency Medicine residents from the Boonshoft School of Medicine who were instrumental in helping to operationalize the TeamSTEPPS principles in simulation scenarios with undergraduate nursing students.

References

Adamson, K. A., Kardong-Edgren, S., & Wilhaus, J. (2013). An updated review of published simulation evaluation instruments. *Clinical Simulation in Nursing*, *9*(9), e393-e400. http://dx.doi.org/10.1016/j.ecns.2012.09.004.

Agency for Healthcare Research and Quality [AHRQ]. (2015). *TeamSTEPPS® website*. Retrieved May 28, 2015 from http://teamstepps.ahrq.gov/.

American Association of Colleges of Nursing. (2008). *The essentials of baccalaureate education for professional nursing practice*. Washington, DC: American Association of College of Nursing.

Beitlich, P. (2015). TeamSTEPPS® implementation in the LD/NICU settings. *Nursing Management*, *46*(6), 15-18.

Berkenstadt, H., Haviv, Y., Tuval, A., Shemesh, Y., Megrill, A., Perry, A., …, & Ziv, A. (2008). Improving handoff communications in critical care: Utilizing simulated-based training toward process improvement in managing patient risk. *Chest*, *134*, 158-162.

Billings, D. M., & Halstead, J. A. (2011). *Teaching in nursing: A guide for faculty* (4th ed.). St. Louis, MO: Saunders Elsevier.

Cooper, S., Cant, R., Porter, J., Sellick, K., Somers, G., Kinsman, L. D., & Nestel, D. (2010). Rating medical emergency teamwork performance: Development of the Team Emergency Assessment Measure (TEAM). *Resuscitation*, *81*(4), 446-452. http://dx.doi.org/10.1016/j.resuscitation.2009.11.027.

Decker, S. I., Anderson, M., Boese, T., Epps, C., McCarthy, J., Motola, I., …, & Scolaro, K. (2015). Standards of best practice: Simulation standard VIII: Simulation-enhanced interprofessional education (sim-IPE). *Clinical Simulation in Nursing*, *11*(6), 293-297.

DeVellis, R. F. (2003). *Scale development: Theory and applications* (2nd ed.). Thousand Oaks, CA: SAGE Publications.

Ellis, D., Crofts, J. F., Hunt, L. P., Read, M., Fox, R., & James, M. (2008). Hospital, simulation center, and teamwork training for eclampsia management: A randomized control trial. *Obstetrics and Gynecology*, *111*(3), 723-731.

Fletcher, G., Flin, R., McGeorge, P., Glavin, R., Maran, N., & Patey, R. (2003). Anaesthetists' non-technical skills (ANTS): Evaluation of a behavioural marker system. *British Journal of Anaethesia*, *90*(5), 580-588.

Guise, J. M., Deering, S. H., Kanki, B. G., Osterweil, P., Li, H., Mori, M., & Lowe, N. K. (2008). Validation of a tool to measure and promote clinical teamwork. *Simulation in Healthcare*, *3*(4), 217-223. http://dx.doi.org/10.1097/SIH.0b013e31816fdd0a.

Hayden, J., Keegan, M., Kardong-Edgren, S., & Smiley, R. A. (2014). Reliability and validity testing of the Creighton Competency Evaluation Instrument for use in the NCSBN National Simulation Study. *Nursing Education Perspectives*, *35*(4), 244-252.

Jeffries, P. R. (2012). *Simulation in nursing education: From conceptualization to evaluation* (2nd ed.). New York: National League for Nursing.

Kim, J., Neilipovitz, D., Cardinal, P., Chiu, M., & Clinch, J. (2006). A pilot study using high-fidelity simulation to formally evaluate performance in the resuscitation of critically ill patients: The University of Ottawa critical care medicine, high-fidelity simulation, and crisis resource management I study. *Critical Care Medicine*, *34*(8), 2167-2174.

Lynn, M. R. (1986). Determination and quantification of content validity. *Nursing Research*, *35*, 382-385.

Malec, J. F., Torsher, L. C., Dunn, W. F., Wiegmann, D. A., Arnold, J. J., Brown, D. A., & Phatak, V. (2007). The mayo high performance teamwork scale: Reliability and validity for evaluating key crew resource management skills. *Simulation in Healthcare*, *2*(1), 4-10.

Morey, J. C., Simon, R., Jay, G. D., Wears, R. L., Salisbury, J. C., Dukes, K. A., & Berns, S. D. (2002). Error reduction and performance improvement in the emergency department through formal teamwork training: Evaluation results of MedTeams project. *Health Services Research*, *37*(6), 1553-1581.

Sando, C. R., Coggins, R. M., Meakim, C., Franklin, A. E., Gloe, D., Boese, T., …, & Borum, J. (2013). Standards of best practice: Simulation standard VII: Participant assessment and evaluation. *Clinical Simulation in Nursing*, *9*(6 Suppl), S30-S32. http://dx.doi.org/10.1016/j.ecns.2013.04.007.

Shapiro, M. J., Morey, J. C., Small, S. D., Langford, V., Kaylor, C. J., Jagminas, L., …, & Jay, G. D. (2004). Simulation based teamwork training for emergency department staff: Does it improve clinical team performance when added to an existing didactic teamwork curriculum? *Quality and Safety Health Care*, *13*(6), 417-421.

Shrout, P. E., & Fleiss, J. L. (1979). Intra-class correlations: Uses in assessing rater reliability. *Psychological Bulletin*, *86*, 420-428.

Siassakos, D., Bristowe, K., Draycott, T. J., Angouni, J., Hambly, H., Winter, C., & Crofts, J. F. (2011). Clinical efficiency in a simulated emergency and relationship to team behaviours: A multisite cross-sectional study. *British Journal of Obstetrics and Gynecology*, *118*(5), 596-607. http://dx.doi.org/10.1111/j.1471-0528.2010.02843.x.

Sigalet, E., Donnon, T., Cheng, A., Cooke, S., Robinson, T., Bissett, W., & Grant, V. (2013). Development of a team performance scale to assess undergraduate health professionals. *Academic Medicine*, *88*(7), 989-996. http://dx.doi.org/10.1097/ACM.0b013e318294fd45.

Steinemann, S., Berg, B., Skinner, A., DiTulio, A., Anzelon, K., Terada, K., …, & Speck, C. (2011). In situ, multidisciplinary, simulation-based teamwork training improves early trauma care. *Journal of Surgical Education*, *68*(6), 472-477. http://dx.doi.org/10.1016/j.jsurg.2011.05.009.

Ten Eyck, R. P., & Smith, S. (2013). TeamSTEPPS essentials presentation and an interprofessional high-fidelity simulation on nursing students' attitudes toward medical team operations. *Simulation in Healthcare*, *8*(6), 96.

Walker, S., Brett, S., McKay, A., Lambden, S., Vincent, C., & Sevdalis, N. (2011). Observational skill-based clinical assessment tool for resuscitation (OSCAR): Development and validation. *Resuscitation*, *82*(7), 835-844. http://dx.doi.org/10.1016/j.resuscitation.2011.03.009.