Original Article

The Effect of High-Fidelity Simulation on Experiences of Urinary Catheterization in Nursing Students: A Mixed-Method Systematic Review

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Abstract

Background: Simulation-teaching methods make it easier for students to learn urinary catheterization skills, which may present a number of issues.

Methods: This mixed-methods systematic review was conducted to examine the effectiveness of High-Fidelity Simulation (HFS) methods on teaching urinary catheterization skills to nursing students.

Results: This study revealed nursing students' experiences of using HFS methods. Four studies were included, which had been conducted as quantitative studies (n=2), and mixed-methods studies (n=2). HFS methods using a reactive and realistic environment are useful in developing students' urinary catheterization skills, including their practical abilities and competence, as well as improving their self-confidence and ability to communicate.

Conclusion: The effect of HFS on students' experiences of urinary catheterization was highly positive. In this regard, it is recommended that HFS methods be used to gain and maintain these skills. Further research could be carried out with larger sample groups.

Keywords: urinary catheterization; simulation; nursing education; nursing students

Introduction

Gaining and maintaining cognitive, affective and psychomotor skills are important for nursing students since nursing science is largely skill-based and practice-oriented; experienced and qualified nurse educators generally teach these skills are taught to the students (Aldridge and Hummel, 2019, Eyikara and Baykara, 2017, George, 2019). However, there is a still deficit between theoretical knowledge learned in nursing education and the skills than need to be demonstrated in professional life (Brown, 2019). Kavanagh and Szweda (2017) reported that only 23% of newly graduated nurses carry out their nursing practices to a competent level. In fact, since students may only have limited chances to practice their skills during their education, they may have difficulty performing their duties safely during the first year of their professional lives (Butt et al., 2018).

Additionally, many nursing students rely solely on their memories to integrate their theoretical knowledge and skills to practices, even though they affected negatively to learn actively (Gonzalez and Sole, 2014). Nurse educators who are aware of these issues generally attempt to teach the required skills to nursing students using different learning methods and teaching environments, and to do so in a way that enables students to competently transfer their knowledge into practice (Terzioglu et al., 2016).

Urinary catheterization skills are generally teached early in nursing curriculum, although they can be hard for novice nursing students to learn. They are also one of the nursing practices with the highest rate of medical errors due to breaching in catheterization technique. Poor catheterization skills are cause of health problems such as Catheter-associated Urinary Tract Infections (CaUTI), trauma of the urethra, and other issues in addition to the existing illness; they also contribute towards increasing incremental costs for hospitals (Gonzalez and Sole, 2014, Lengetti et al., 2018).

Urinary insertion requires deep knowledge, basic skills, and the maintenance of an aseptic technique during the implemantation, and is thus one of the hardest practices in nursing (Gonzalez and Sole, 2014, Öztürk and Dinç, 2014). In nursing education, High-Fidelity Simulation (HFS) methods are used to enable students to gain urinary catheterization skills, as they are for other psychomotor skills, and to allow them to become competent in practicing them (Gonzalez and Sole, 2014).

Simulation-based technologies have been more widely used as teaching methods in recent years as educators' interest in the concept of clinical competence has continued to grow (Aldridge, 2017). Using simulations provides an opportunity for students to combine their nursing knowledge and skills while increasing their motivation to learn, their ability to identify and correct mistakes, and developing their professional autonomy and competence (Murphy and Janisse, 2017, Walters et al., 2017).

These learning methods allow nursing educators and students to teach and learn these skills in a controlled and stress-free environment with no possiblity of harm to a patient while closely resembling real-life situations; clinical decisions can be made and observed with no risk and a low level of anxiety (Jacobs et al., 2020). Through HFS, students have greater opportunities to learn how to apply their knowledge by watching and undertaking practical demonstrations (Jarvill et al., 2018).

However, although the concept of clinical competence has been well studied by researchers, more research is still needed into the effectiveness of HFS methods on the acquisition of nursing skills (Lejonqvist et al., 2016).

The number of studies specifically about the effects of HFS methods on urinary catheterization is even more limited. This study thus aimed to address the impact of HFS methods on nursing students' learning of urinary catheterization skills.

Method

Study Objective

The Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) statement consisting of a 17-item checklist was used to prepare and report the results of this study (Moher et al., 2015).

The objective of this review was to identify and synthesize the evidence on the effectiveness of using HFS methods to teach urinary catheterization skills to nursing students. The research questions were as following;

a) What were the procedures for using HFS methods?

b) What was the impact of HFS methods on nursing students'experiences of urinary catheterization?

c) What were the factors affecting the outcomes of using HFS methods?

Eligibility Criteria

First, the characterics of the studies to be included in this systematic review were delimited based on PICO, study design, publication status, language and year.

(1) *Population-P*: Nursing students' aged >18 years;

(2) *Interventions-I*: HFS methods to gain and maintain urinary catheterization skills;

(3) *Comparators-C*: Another simulation (low-fidelity, virtual simulation methods, etc.) and educational methods (e-learning, peer education methods, etc.), one group pre-post comparison;

(4) *Outcomes-O*: Objective measure of urinary catheterization skills' and factors affecting HFS methods; and

(5) *Study designs-S:* Quantitative and qualitative studies, or mixed-method studies that were peer-reviewed research studies. The remaining eligibility criteria were: publication of the peer-reviewed articles as full-text in English. In addition to, the other criteria was that publications were published between January 2000 and August 2020 were included to this review study since it was stated that the oldest studies found were from 2001 (Solnick and Weiss, 2007).

The exclusion criteria were

(1) *P:* students were < 18 years old or graduated nurses;

(2) *I:* another simulation or other educational methods focusing on different nursing issues and skills;

(3) *C:* studies without a comparator were not excluded; (4) *O:* outcome indicators and factors were not about urinary catheterization skills (5) *S:* they were abstracts, editorials, protocols, theses or dissertations, comments or literature reviews without original data (Table 1).

Search strategy

The databases of PubMed, CINAHL, Scopus, Cochrane Library and Web of Science archives were searched to access studies meeting the eligibility criteria. Other sources, such as Google Scholar, were searched independently by the researchers to access other free text articles.

The search was conducted systematically using MesH terms, other literature keywords, and Boolean operators: ("urinary catheterization," OR "ureteral catheterization" OR "urethral catheterization" OR "foley catheterization" OR "intermittent urethral catheterization" OR "urinary insertion*")[1] AND ("simulation" OR "simulation training"OR "high fidelity simulation training")[2] AND ("nursing" OR "nursing student" OR "nurses")[3] AND combinations of these words[1-3].

Search selection

All the resulting articles were uploaded to Endnote database after they had been examined by the reviewers. All irrelevant articles and duplicates were removed from this database.

The researchers examined the remaining articles independently according to the eligibility criteria. At this stage the reviewers agreed on which studies would be included in the systematic review. All the included and excluded studies are summarized in accordance with the PRISMA standards.

Quality appraisal methods

The studies' methodological quality and risk of bias for randomized and non-randomized experimental studies (n=1) were assessed based on the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Randomized Controlled Trials and Quasi-Experimental Studies. For quality of mixed-methods studies (n=2), each substudy based on qualitative and quantitative methods was appraised separately using the JBI Critical

Appraisal Checklist for Randomized Controlled Trials, or Quasi-Experimental Studies, or Qualitative Research (Lockwood et al., 2020, Tufanaru et al., 2020). The assessment process was conducted by two reviewers as follows:

(1) first, each study was appraised independently by each reviewer;

(2) second, the Kappa value was assessed to measure the consistency of the two reviewers using the SPSS 22.0 program (SPSS IBM, Turkey;

(3) the reviewers' assessments were compared, and a higher Kappa value, indicating strong consistency between the reviewers, was found (.932); and

(4) finally, a discussion was held to establish a consensus. To prevent publication bias, each of the studies was assessed with regard to identifying overlapping data between substudies; however, none of the data appeared to be repeated. Using the JBI Critical Appraisal Tools, studies were included based on their methodological quality. Given the paucity of research in this area, all relevant studies which met the eligibility criteria were included.

Data Synthesis

A meta-analysis was not performed due to the heterogeneity of studies' methods, including their aims and designs, the data collection tools, their outcomes, etc. (In: Higgins et al., 2019). The characteristics of the studies included were, however, synthesized and presented in line with the PICO.

Convergent synthesis for parallel results was used in this systematic review to synthesize independently the results of qualitative, quantitative, and mixed-method studies. In mixed-methods systemic reviews with two or more study questions, this synthesis method is the most commonly used (Hong et al., 2017). It enables all types of studies' methods and findings to be transferred into qualitative findings, to be presented in narrative form, and for complementary analysis of the mixed evidence to be conducted (Hong et al., 2017, Pluye and Hong, 2014).

The findings were categorised into three main themes and six sub-themes based on the literature reviewed as follows: (1) simulation procedures (characteristics of simulators and characteristics of simulated environments); (b) HFS impact (positive and negative outcomes); and (c) the factors affecting outcomes (barriers to and facilitators of simulation methods).

Results

Characteristics of the participants and the studies included

The characteristics of the studies included are presented in Table 2. The four studies were carried out with undergraduate nursing students (n=148), and had sample sizes varying from 19 to 62 participants, composed of freshmen (n=39), juniors (n= 27), and seniors/final year students (n= 82). The studies were published between 2008 and 2020 and conducted in the USA (n = 3; 75%) and Australia (n = 1; 25%). Of the studies included, one was a randomized-controlled trial (Grady et al., 2008), one was a pre- and post-test study (Kiernan and Olsen, 2020), and two were mixed-method studies (Frost and Delaney, 2019, Johnson et al., 2020). The duration of the studies was between approximately seven and 21 weeks (Table 2).

Education methods

Three studies were conducted to train students in urinary catheterization skills within the scope of the courses and practicums in the routine education curriculum (Kiernan and Olsen, 2020, Johnson et al., 2020, Grady et al., 2008).

On the other hand, Frost and Delaney (2019) provided information to develop students' already existing urinary catheterization skills in clinical workshops. Although the educators who provided the simulation education were not clearly defined in one study (Grady et al., 2008), it was stated in the other three studies that the educators were an

faculty member (Kiernan and Olsen, 2020), an expert educator (Frost and Delaney, 2019), and the researcher (Johnson et al., 2020). However, none of studies clearly described the characteristics of the educators (Table 2).

In three studies, the educators first demonstrated urinary catheterization to the students and then all the students (Grady et al., 2008, Kiernan and Olsen, 2020) or some groups of students (Johnson et al., 2020) practiced this skill under the guidance of their educators using the procedures they had just been shown. In one study, this skill was not taught or demonstrated since the researchers included final year students who had previously learned how to perform urinary catheteterization via low-fidelity simulation education (Frost and Delaney, 2019). Addionally, none of the research papers specified how long the class teaching these procedures lasted.

Characteristics of the simulations and the comparisions

HFS methods were used in the intervention groups: a mannequin with realistic anatomy and clinical functionality (Grady et al., 2008), deliberate practice combined with scenarios providing highly realistic and interactive learning experiences to improve skills (Johnson et al., 2020, Kiernan and Olsen, 2020), and a Mask-Ed simulation technique portraying a realistic character not recognized by students (Frost and Delaney, 2019).

For the control groups, one study used a low-fidelity mannequin (Grady et al., 2008) while one had no intervention (Johnson et al., 2020). Two studies had no control groups since their quantitative methods utilized a one-group pre-and post-test design (Kiernan and Olsen, 2020, Frost and Delaney, 2019).

A pre-brief session about learning objectives and simulation sessions was provided to students only by Frost and Delaney (2019). In all the studies, all the students performed urinary insertion. Each sessions of skills practice lasted approximately 28 minutes, with a minimum of 15 minutes (Johnson et al., 2020) and a maximum of 35 minutes (Kiernan and Olsen, 2020). Two observers assessed the students' performances in three of the studies (Grady et al., 2008, Johnson et al., 2020, Kiernan and Olsen, 2020), while one observer assessed their performance in Frost and Delaney (2019) study.

However, the inter-rater reliabilities of the observers' assessments were not determined in two of the studies (Frost and Delaney, 2019, Kiernan and Olsen, 2020). In two studies, videos were recorded to assess all the students' performance, and to use them in debriefing sessions (Kiernan and Olsen, 2020), or to for the second examiner to re-mark (Johnson et al., 2020). Frost and Delaney (2019) recorded audio from the focus-group interviews to analyze qualitatively.

Debriefing sessions were conducted in two studies to facilitate students' learning and practice, and to allow them to self-assess (Kiernan and Olsen, 2020, Frost and Delaney, 2019). Johnson et al. (2020) conducted semistructured interviews with the students to ask them about their perceptions of the simulation as a part of study's qualitative procedures.

These were similar to debriefing sessions, although the reserachers did not state clearly that debriefing sessions were conducted. Half of the students from each group was interviewed at the same time to ask about their experience of the using a planned simulation (Table 2).

Effects of HFS

The effects of HFS are presented in Table 2. The subjective outcomes (caring for a person, intimate care and communication (Frost and Delaney, 2019), clinical competence (Kiernan and Olsen, 2020, Johnson et al., 2020), attitudes about the simulator-based skill training and self-assessment of performance (Grady et al., 2008), and perceptions of peer-to-peer practice

combined with HFS (Johnson et al., 2020)) were assessed by synthesizing the responses from the audio recordings of the focus-group interviews (Frost and Delaney, 2019), or a semistructured interview (Johnson et al., 2020), or self-rating instruments (Self-Report Questionnaires (Grady et al., 2008) and Clinical Competence Questionnaire (Kiernan and Olsen, 2020)).

On the other hand, the objective outcomes (confidence (Frost and Delaney, 2019) and performance (Johnson et al., 2020, Grady et al., 2008)) were assessed through objective instruments such as checklists (Grady et al., 2008, Johnson et al., 2020) or a 5-point Likert scale (Frost and Delaney, 2019) with which an observer directly rated the students' performances.

However, the validity of the data tools were not assessed in two studies (Johnson et al., 2020, Frost and Delaney, 2019).

One study that compared two groups of students included randomized participants in both the intervention and control groups. In this study, students demonstrated better performance on urinary catheter insertion with high-fidelity than low-fidelity mannequin training following 13 half-hour training sessions ($p<0.05$).

Additionally, students reported that they had more positive attitudes toward the high-fidelity mannequin ($p<0.05$), since they thought it provided a more realistic environment and responsiveness (Grady et al., 2008).

In one single-group study of junior and senior nursing students in high-fidelity simulation scenarios, which measured urinary catheter insertion and care competence based on a pre- and post-test self-assesment, juniors reported a decrease in skills or no improvement, whereas seniors had a significant upward trend (Kiernan and Olsen, 2020).

The two studies conducted as mixed-methods studies included qualitative and quantitative results for only one group. They reported that students' confidence increased and they became more competent in performing urinary catheterization when they had participated in a HFS (Frost and Delaney, 2019, Johnson et al., 2020).

According to the qualitative results of Frost and Delaney (2019), the students stated that the simulation developed their ability to correctly identify the anatomical structure of females, and replicated a clinically realistic experience by challenging their ability to communicate and perform the skill at the same time, as when caring for a real person (Frost and Delaney, 2019). Johnson et al. (2020) also reported that students performing urinary catheter insertion during HFS scenarios made progress in retaining their competency in this skill after 21 weeks.

However, some students reported that they felt stressed and under pressure due to the questions of the simulated patient and the time limit imposed on performing the insertion.

Factors affecting outcomes

In all the studies, the HFS was the most important factor affecting the outcomes related to urinary catheterization (Grady et al., 2008, Kiernan and Olsen, 2020, Johnson et al., 2020, Frost and Delaney, 2019). Providing a more realistic care environment as well as an actual patient and receiving immediate feedback during HFS contributed to an increase in both students' confidence (Frost and Delaney, 2019) and their successful performance (Frost and Delaney, 2019, Grady et al., 2008). Grady et al. (2008) reported that male students' performance and attitudes were more positively affected by high-fidelity mannequin technology than female students. On the other hand, in one study, students reported that peer-to-peer deliberate practice combined with HFS scenarios helped them to feel comfortable and relax, while also providing an opportunity for reflection (Johnson et al., 2020).

Table 1. Inclusion criteria based on PICOS framework

PICOS	Inclusion criteria	Exclusion criteria
Population (P)	– Nursing students aged >18 years	– Students were < 18 years old – Qualified nurses
Interventions (I)	– High-fidelity simulation methods to gain and maintain urinary catheterization skills	– Other simulation methods focused on other nursing issues and skills – Other educational methods focused on other nursing issues and skills
Comparators (C)	– Another simulation and educational methods/ one group pre-post comparison	– Studies without a comparator were not excluded
Outcomes (O)	– Objective measure of urinary catheterization skills – The factors affecting high-fidelity simulation methods	– Outcome indicators and factors were not about urinary catheterization
Study designs (S)	– Quantitative, qualitative studies or mixed-method studies that are peer-reviewed research studies.	– Abstracts, editorials, protocols, theses and dissertations, comments or literature reviews without original data

Discussion

The increasing popularity of HFS methods in nursing education provides opportunites for effective teaching of practice skills (psychomotor skills) using realistic scenarios; they also aid in the learning of critical thinking (cognitive skills) and the ability to reflect on one's experience (affective skills) (Edward and Chukwuka, 2020, Hallin et al., 2016).

Urinary catheterization is one of the fundamental nursing skills that needs to be learnt prior to graduation. HFS methods offer the experiences, competence and confidence required for learning and teaching the multi-dimensional nature of urinary catheterization skills (Cason et al., 2017). This systematic review was thus conducted to evaluate the role of HFS on nursing students' development of these skills.

For the first question of this review, the objective was to identify and compare the procedures used for the HFS. In this regard, the time taken to assess the students' performance was approximately similar in all the studies. On the other hand, a prebriefing session was conducted in only one study (Frost and Delaney, 2019). In one study, one observer assessed the students' performance during the simulation (Frost and Delaney, 2019) and no debriefing session was conducted in two studies (Johnson et al., 2020, Grady et al., 2008). Kiernan and Olsen (2020) recorded video of the students to use in debriefing sessions. The International Nursing Association for Clinical Simulation and Learning (INACSL 2016a, 2016b)

Standards Commitee recommendations for effective health care simulations are to (1) begin simulation-based experiences with a prebriefing; (2) use more than one evaluator for each participant, either directly observing or watching a video recording (Committee, 2016b); and (3) provide appropriate, team-based structured debriefing and feedback as appropriate for the goal of the simulation (Committee, 2016a). Jeong and Choi (2017) stated that debriefing based on the clinical judgement model is effective for improving clinical competencies in complex clinical settings such as palliative care units. Additionally, Yeun et al. (2020) stated that students viewing a video-recording of own performance is one of the most important methods for learning nursing skills effectively as well as engaging them in critical thinking .

For the second question of this review, the objective was to identify and compare the impact of HFS on nursing students'experiences of urinary catheterization. The results of the studies included in this study provided limited valid evidence about the effect of HFS on the nursing students' urinary catheterization skills. The reasons for this limited valid evidence were:

(1) some studies had low methodological quality (Frost and Delaney, 2019, Johnson et al., 2020);

(2) the data collection tools were not validated (Frost and Delaney, 2019, Johnson et al., 2020);

(3) the validity and inter-rater reliability of the observers' assessments were not analyzed (Kiernan and Olsen, 2020, Frost and Delaney, 2019);

(4) some studies were conducted with small sample sizes (Frost and Delaney, 2019, Johnson et al., 2020); and

(5) treatment groups were not similar at the baseline (Johnson et al., 2020).

The limitations in the studies' methodological quality and the risk of bias were taken into account while interpreting their results. Nevertheless, the findings of this review indicate that HFS did have an effect on th the urinary catheterization skills fo the nursing students (Grady et al., 2008, Frost and Delaney, 2019, Johnson et al., 2020, Kiernan and Olsen, 2020).

The major themes in the research were that using HFS improves students' performance (Grady et al., 2008, Frost and Delaney, 2019, Johnson et al., 2020), confidence (Frost and Delaney, 2019) and clinical competence (Kiernan and Olsen, 2020, Johnson et al., 2020) in urinary catheterization. This is significant, because previous studies (Blum et al., 2010, Sundler et al., 2015) have also stated that using HFS improved nursing students' self-confidence and levels of competence. Similarly, D'Souza et al. (2017) stated that knowledge, performance, and confidence improved among nursing students using HFS for nursing care in a critical care setting.

In terms of the third objective, the systematic review found that students' genders (Grady et al., 2008), having realistic experiences (Frost and Delaney, 2019), and a combination of HFS with other education methods (peer-to-peer deliberate skill practice) (Johnson et al., 2020), were the factors which affected the students' urinary catheterization skills. In the literature, there is a gap in terms of the effect of gender on care practices taught through simulation methods. Several studies have indicated that students learning different nursing care skills through HFS methods had better scores for clinical performance than those in control groups (Aqel and Ahmad, 2014, Ryoo et al., 2013).

This result was expected given that HFS can provide realistic physiological responses to learners' action in safe controlled environments (Hallin et al., 2016). Similarly, Dennis et al. (2020) discuss the potential of using peer-assisted and simulation-based learning together in the development of future training methods in health care education.

On the other hand, in their studies comparing the effects of a simulation integrated with problem-based learning, Yun and Choi (Yun and Choi, 2019) recommended that such integration should be implemented appropriately and sequentially, with consideration of the overall goal of the education. In the light of these various studies, it can be said that HFS methods are likely to be most effective when they are combined with other educational techniques.

Limitations

There were several limitations to this study. A meta-analysis was not conducted due to the various study designs and the different outcomes measured. The research questions were confined to description and the results obtained were interpreted with caution, since only a restricted number of published studies were relevant to the research theme, especially in terms of randomized controlled trials.

In this regard, the quality of the evidence in the studies included cannot be verified. In addition, since only studies found in five databases, and only studies published in English between January 2000 and August 2020, were included in this systematic review, some relevant articles might have been missed. Three out of the four studies presented the results of American students' experiences of learning urinary catheteterization and the results of this study thus cannot be generalized for students in other countries.

Conclusions

Urinary catheterization skills are of great signficance; they also require the maintenance of sterility which is important for patient safety. However, since most student have only a restricted opportunity to practice before performing these skills in clinical settings, they fail to retain their competency in these skills in the long term (Butt et al., 2018). Nursing students need guidance from their educators and the chance to consistent repeat these skills in order to be able to implement them safely and become competent in them(Kardong-Edgren et al., 2019).

HFS methods are one of the alternative teaching and learning strategies for urinary catheteterization skills. This study may be able to serve as a foundation for the

development of nursing students' urinary catheterization skills through HFS methods, because it provides relevant evidence about the effectiveness of HFS.

However, because most of the studies included in this systematic review had a qualitative or a one-group pre- and post-test quasi-experimental study design, further studies are needed to increase generalizability using randomized controlled trials, appropriate sample size, and longitudinal studies. In addition, valid measurements are needed to assess the main outcomes of HFS education, and the factors affecting these outcomes.

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Table 2. Characteristics of participants and studies

Authors, years	Countries	Study design	Sample sizes and population / Duration of the studies	Education methods/Educators	Simulation methods/Observers	Length of each simulation session	Debriefing session	Measurement	Outcomes
Grady et al. 2008	USA	RCT	39 freshmen/ approximately seven weeks	The courses and practicums in the routine educational curriculum/ Not addressed	High-fidelity vs. low-fidelity mannequin in two groups/ Two observers from among nine instructors for each session	30 minutes	No debriefing	Urinary catheter insertion skill acquisition levels and perceptions of simulator utility	-Students demonstrated higher performance on urinary catheter insertion with high-fidelity than with low-fidelity mannequin training. -They thought the high-fidelity mannequin provided a more realistic environment and responsiveness.

Kiernan and Olsen 2020	USA	One-group pre- and post-test quasi-experimental study design	27 juniors and 35 seniors/ 15 weeks	The courses and practicums in the routine educational curriculum/ Faculty member	High-fidelity scenarios/ Two observers	35 minutes	40 minutes of debriefing was conducted by faculty member	Urinary skill catheter insertion competency levels	-Juniors reported a decrease or no improvement, whereas seniors had a significant upward trend for urinary catheter insertion and care competence in high-fidelity simulation scenarios.
Frost and Delaney 2019	Australia	Mixed-methods study design	19 final year students/five months	Clinical workshop/ Expert educator	High-fideliy simulation using Mask-Ed/ One observer	30 minutes	A debriefing session was conducted by Mask-Ed educator	Confidence levels in existing urinary catheter insertion skills and experiences of the simulation	-Students increased their confidence for the urinary catheterization procedure after participating in a high-fidelity simulation. -Students stated that the high-fidelity simulation replicated a clinically realistic experience by challenging their ability to communicate and perform the skill at the same time,

									as when caring for a real person.
Johnson et al. 2020	USA	Mixed-methods study design	28 seniors/21 weeks	The courses and practicums in the routine educational curriculum/ Researcher	High-fidelity scenarios /Two observers	Between 15 and 20 minutes	No debriefing	Urinary catheter insertion skill competency and retention, and perceptions about the simulation	-Students increased their competence in performing urinary catheterization after participating in the high-fidelity simulation. -Students performing urinary catheter insertion during high-fidelity simulation scenarios made progress in retaining their skill competency, although some of them reported that they felt stressed and under pressure.