The Learning Effectiveness of High-Fidelity Simulation Teaching Among Chinese Nursing Students: A Mixed-Methods Study

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ABSTRACT

Background: High-fidelity simulation (HFS) is an interactive and complex experiential learning pedagogy. Given the limited and inconclusive evidence on the effectiveness of HFS in terms of improving student learning outcomes, a more thorough understanding of students’ learning experiences and effects of HFS may inform the improvement of nursing training.

Purpose: The aim of this study was to examine the learning effectiveness score of HFS, its influencing factors, and the learning experience of nursing students.

Methods: A convergent parallel mixed-methods research design was adopted. Five hundred thirty-three third-year undergraduate nursing students completed the Simulation Learning Effectiveness Inventory. Semistructured interviews were used to elicit the opinions of 22 participants regarding their participation in the HFS experience.

Results: The quantitative findings showed a moderately high learning effectiveness of HFS among Chinese undergraduate nursing students (121.81 ± 14.93). The learning effectiveness for equipment resources (15.02 ± 2.38), course arrangement (11.18 ± 1.73), and confidence (18.56 ± 3.67) was relatively low. Extroversion and mixed personality (β = 0.14 and 0.10) and “dislike” or “general like” of the course (β = −0.45 and −0.33) were found to influence learning effectiveness (F = 54.79, p < .001, adjusted R² = .29). In addition, the qualitative findings indicated that the participants felt positively regarding the “debriefing,” “clinical abilities,” and “problem solving” dimensions of the training.

Conclusions/Implications for Practice: The focus of the education process and curriculum design of HFS activities should be on improving course arrangement, equipment resources, and students’ confidence while paying attention to nursing students’ personality traits and course preferences.

KEY WORDS:
high-fidelity simulations, nursing, students, mixed-methods design, learning.

Introduction

Emerging health needs and high patient expectations face nurses today, especially those in China, with substantial challenges in delivering high-quality care (Gu et al., 2018). Because of the deterioration of nurse–patient relationships and the growing attention to patient safety issues, undergraduate nursing students’ opportunities to experience direct patient care and clinical practice have been decreasing (Gu et al., 2018; Kim et al., 2016). High-fidelity simulation (HFS) is as ideal substitute for traditional clinical settings, providing nursing students with opportunities to practice decision-making and clinical skills under a wide range of scenarios in a safe, supportive, and realistic clinical environment to meet future nursing challenges without compromising the well-being of patients (Sundler et al., 2015). Thus, HFS has been used widely in nursing education, including in classroom and continuing nursing professional education in clinical practice settings (Kunst et al., 2017).

HFS is an interactive strategy that uses more than computer-based mannequins to show realistic clinical interactions and clinical scenarios (Au et al., 2016). As Jeffries and Rogers (2007) noted, evaluating student learning experiences and outcomes over the phases of HFS is an important component of the teaching process, because it helps instructors assess learning and performance and further improve and refine their teaching strategies (Chen et al., 2015). However, many nurse educators continue to struggle with the problem of how to evaluate the effectiveness of these simulations (Bai et al., 2015; Chu & Chen, 2016).

A substantial body of research findings indicates that HFS may have positive effects on student self-efficacy, learning satisfaction, psychomotor skills, and critical thinking (Aebersold et al., 2018). However, evidence regarding the effect of HFS on student learning efficacy is inconsistent and...
mixed (Yang & Liu, 2016). Nursing educators have highlighted the need to further assess HFS-based teaching strategies and their impact on learning (Blum et al., 2010). Moreover, personal characteristics such level of enthusiasm for the nursing profession, whether a student is a class leader, and personality type may influence the degree to which students engage in their studies (Lin et al., 2018). Further exploration of the factors that influence the learning effectiveness of HFS among Chinese nursing students may help nursing educators better understand their HFS-related learning experience.

HFS is an interactive and complex experiential learning pedagogy (Warren et al., 2016). On the basis of Chen et al. (2015), the learning effectiveness of HFS in this study was defined as the degrees of improvement in clinical ability, confidence in taking care of patients, collaboration with others, and participation in problem-solving activities. Given the limited and inconclusive evidence regarding the effectiveness of HFS, further study is necessary to triangulate the quantitative and qualitative data to provide more comprehensive insight into nursing students' HFS learning experiences and the effectiveness of HFS. Davis et al. (2014) explored the opinions of nursing faculty regarding HFS application using a parallel mixed-methods approach. To our knowledge, the effectiveness of using HFS among nursing students using a mixed-methods approach has not been assessed.

Therefore, the main aims of this study were to examine HFS learning effectiveness and its influencing factors among undergraduate nursing students in China and to explore their perceptions and learning experiences regarding HFS. This study was designed to provide insights that may be applied to the future development and improvement of HFS teaching among nursing students, informing the potential for further integrating HFS into nursing educational curricula.

### Methods

#### Study Design

This sequential parallel mixed-methods research study (Curry et al., 2013) was conducted from June to August 2018. First, self-administered questionnaires were used to assess HFS learning effectiveness in a group of undergraduate nursing students and to collect related sociodemographic and learning characteristics. Then, semistructured interviews were used to explore the opinions of nursing students regarding their HFS learning participation experience. The quantitative and qualitative components of this study were prioritized equally. Ethics approval was obtained from the ethics committee of Fujian Medical University (no. 20170322).

#### Measurement

The Mandarin Chinese version of the Simulation Learning Effectiveness Inventory (SLEI-SCM; Huang et al., 2019) was adapted from the 31-item, self-report SLEI (Chen et al., 2015). The SLEI-SCM includes three subscales that are used to assess the six domains of HFS learning effectiveness. These domains include course arrangement, equipment resources, debriefing, clinical abilities, problem solving, and confidence. Each item is scored using a Likert-type 5-point scale (1 = strongly disagree and 5 = strongly agree), and the instrument has a total possible score range of 31–155, with higher scores indicating higher levels of learning effectiveness. The SLEI-SCM has confirmed reliability and validity (Huang et al., 2019), with a Cronbach’s α of .95 and a 2-week test–retest reliability of .88.

Demographic information collected from the participants included age, gender, birthplace, whether the student was from a single-child family, whether the student was a class leader, personality type, and whether the student was personally motivated to join the nursing profession. Information on course learning was also collected, including the most impressive experience of HFS learning, the number of role-playing activities participated in, HFS learning preference, and the perceived benefits of HFS learning.

#### Participants

Five hundred thirty-three third-year undergraduate nursing students were recruited using a nonprobability, convenience, purposive sampling method from a 4-year nursing bachelor program of a medical university in southern China. Students who had completed all 13 HFS classes and were willing to participate were invited to complete the survey, and those who completed the survey were invited to freely and voluntarily share their perceptions of the HFS learning experience. Twenty-two eligible students of various backgrounds (e.g., gender, personality type) were purposively selected to participate in additional, semistructured, individual, in-depth interviews. This sample size met the criteria for theoretical saturation after coding (Speziale & Carpenter, 2007).

#### The High-Fidelity Simulation Activities

HFS was conducted as a regular part of the curriculum (nursing comprehensive experiment) in a five- and six-semester course of the program undertaken in the simulation nursing laboratory before clinical placement. The HFS course included the use of computerized full-body manikins (METIman Nursing) in a simulated clinical care area, with a viewing room and an adjacent facilitator control room. The purpose of this course was to better cultivate the ability of students to provide nursing care to patients experiencing medical and surgical diseases (e.g., chronic obstructive pulmonary diseases, peptic ulcers, cerebral trauma) and to prepare students for clinical placement.

The HFS course included 13 class sessions, covering common diseases in the fields of medical, surgical, gynecological, and pediatric nursing. During each 2-hour HFS class, students were divided into groups of 16–20 and then further divided into subgroups of three to five for each activity. Generally, three scenarios were performed during each HFS class. Students in each subgroup performed one HFS scenario and were assigned different individual roles, mostly nurses, whereas the students in other subgroups acted as observers. The roles of observer and active participant/nurse were rotated.
over the course of the entire HFS activity. Three teachers led the course, with one responsible for controlling the computer and simulating the patient’s voice during the simulation stage and two serving as facilitators (e.g., doctor, family member).

The simulation class was a 2-hour period that included a 10-minute briefing and preparation and a 50-minute simulation followed by a 60-minute debriefing. The design of the HFS activities was based on the Jeffries simulation model. The HFS class process is shown in Table 1. These simulations require students to complete assigned prereadings that relate to the corresponding scenarios shown on the student learning management platform.

### Quantitative Data Collection
Immediately after the end of the last HFS class, two nursing master-degree students distributed the demographic and course-related data form and SLEI-SCM to the participants. Completed surveys were returned anonymously in a secured box. The survey took 10–15 minutes to complete.

### Qualitative Data Collection
The qualitative interview guide was developed based on the findings of the quantitative study. In addition, two students were interviewed to further validate the interview script. All of the interviews were held in private at a mutually convenient time for each participant and conducted using the qualitative interview guide. During the interview, the opinions of the interviewees regarding their HFS learning experience were explored in an open and free environment by the interviewers (F. F. H. and A. W.), both of whom hold nursing PhD degrees and are experienced in conducting qualitative studies. Interviews took an average of 40 minutes. The interview responses were transcribed verbatim and translated from Chinese into English, with discrepancies checked by two of the authors. The qualitative interview questions were as follows:

(a) How did your high-fidelity simulation activity experience compare to or differ from the traditional introduction?
(b) What did you gain from the high-fidelity simulation activity?
(c) What were the difficulties or obstacles encountered in the high-fidelity simulation activity?
(d) What are your suggestions for the high-fidelity simulation activity?

### Data Analysis
SPSS 16.0 software (SPSS, Inc., Chicago, IL, USA) was used to analyze the quantitative data. Descriptive analysis of the SLEI-SCM scores and the characteristics of participants were reported using means (± SD) and frequency distributions.

Multiple stepwise linear regression was performed to identify the predictors of HFS learning effectiveness. The SLEI-SCM

### Table 1
The High-Fidelity Simulation Class Process

| Stage/Phase                      | Activity                                                                 |
|----------------------------------|--------------------------------------------------------------------------|
| Before HFS class                 | Self-directed activity of nursing students.                               |
| Online prelearning               | A meeting was held by the subject instructors before class to discuss the design of the activity, while a collective lesson preparation was also run among the instructors to ensure the maximization of learning experience and to seek improvement. |
| Briefing and preparation stage   | (a) Instructors introduced the simulated environment and technology to students. |
| (10 minutes)                     | (b) Instructors introduced the HFS learning objectives, activity, amounts of time given, role specifications, and outcome expectancies. |
|                                  | (c) Role-players (nursing students) made preparations for the HFS activity and became familiar with the simulated environment. |
| During HFS class                 | (a) Role-players (nursing students) performed preprogrammed HFS scenarios by the use of the think-aloud technique in a simulated clinical care area. (The simulation scenarios were video recorded.) |
| Simulation stage (50 minutes)    | (b) Instructors provided cues, help, and obstacles as necessary in an adjacent facilitator control room. |
|                                  | (c) Observers (nursing students) were required to take notes on the clinical presentation, missing data, and reflections in a viewing room. |
| Verbal debriefing stage          | Students were encouraged to review and discuss the following prompts after the simulation under the guidance of the instructors. When in controversy, the instructors used snippets from the video to guide discussion. |
| (60 minutes)                     | (a) Reflecting on what they learned.                                     |
|                                  | (b) Analyzing what went right and what went wrong with the simulations.   |
|                                  | (c) Discussing how to apply knowledge gained to clinical practice.       |
|                                  | (d) Discussing strengths and weaknesses for future practice and improvement. |

Note: HFS = high-fidelity simulation.
score was treated as the dependent variable, and variables showing statistical significance in the t test or one-way analyses of variance, including age, nursing students like the HFS learning, and nursing students’ personality, were designated as independent variables. Missing data were replaced using mean value substitution, and \( p < .05 \) was considered to be statistically significant.

The qualitative data were entered into ATLAS.ti software for content analysis (Green & Thorogood, 2004). Two of the researchers read the interview transcripts independently line by line and generated the preliminary coding using an inductive coding approach. Next, the researchers discussed and compared the preliminary coding until consensus was achieved. When discrepancies arose, the original transcripts were reexamined. Finally, the similar codes were summarized to generate the final themes.

In this study, quantitative data analysis was followed by the analysis of qualitative data, with equal weight given to the findings of both analysis methods (NIH Office of Behavioral and Social Sciences, 2018). Finally, both the quantitative and qualitative data were used to interpret the results, and the data on the preparation, process, and learning outcomes of simulation teaching were integrated during interpretation using the Jeffries simulation framework (Jeffries & Rogers, 2007).

**Results**

Five hundred thirty-three undergraduate nursing students completed the questionnaires, giving a response rate of 96.1%. The mean age of the participants was \( 21.44 \pm 0.87 \) years. The participants had participated in an average of \( 4.05 \pm 1.72 \) simulation sessions. The demographic and course-related characteristics of the participants are summarized in Table 2.

**Table 2**

*Participants’ Demographics and Course Data*

| Characteristic                                      | Survey \((n = 533)\) | Interview \((n = 22)\) | Learning Effectiveness Scores | \(F/t\) | \(p\) |
|-----------------------------------------------------|----------------------|------------------------|------------------------------|--------|------|
|                                                     | \(n\) | \(\%\) | \(n\) | \(\%\) | \(M\) | \(SD\) |        |        |
| Gender                                              |       |        |       |        |      |      |        |        |
| Female                                              | 463   | 86.9   | 20    | 90.9   | 123.77 | 15.96 | 1.17   | .24    |
| Male                                                | 70    | 3.1    | 2     | 9.1    | 121.53 | 14.78 |        |        |
| Birthplace                                          |       |        |       |        |      |      |        |        |
| Urban                                               | 365   | 68.5   | 8     | 36.4   | 121.39 | 14.56 | -1.05  | .30    |
| Rural                                               | 168   | 31.5   | 14    | 63.6   | 122.85 | 14.02 |        |        |
| Whether the student was a single-child family        |       |        |       |        |      |      |        |        |
| Yes                                                 | 97    | 18.2   | 4     | 18.2   | 123.45 | 14.96 | 1.20   | .23    |
| No                                                  | 436   | 81.8   | 18    | 81.8   | 121.41 | 14.86 |        |        |
| Whether the student was a class leader               |       |        |       |        |      |      |        |        |
| Yes                                                 | 219   | 41.1   | 8     | 36.4   | 123.53 | 14.74 | 2.21   | .03*   |
| No                                                  | 314   | 58.9   | 14    | 63.6   | 120.62 | 15.02 |        |        |
| Personal choice to join the nursing profession?      |       |        |       |        |      |      |        |        |
| Voluntary                                           | 235   | 44.1   | 13    | 59.1   | 123.42 | 14.36 | 2.18   | .03*   |
| Involuntary                                         | 298   | 55.9   | 9     | 40.9   | 120.58 | 15.28 |        |        |
| Personality type                                    |       |        |       |        |      |      |        |        |
| Extroverted                                         | 120   | 22.5   | 7     | 31.8   | 118.26 | 13.85 | 8.14   | < .01* |
| Introverted                                         | 125   | 23.5   | 7     | 31.8   | 125.85 | 16.39 |        |        |
| Mixed                                               | 288   | 54.0   | 8     | 36.4   | 121.7  | 14.39 |        |        |
| Preference of HFS learning                          |       |        |       |        |      |      |        |        |
| Like                                                | 274   | 51.4   | 16    | 72.7   | 129.01 | 13.16 | 103.36 | < .01* |
| General                                             | 241   | 45.2   | 2     | 9.1    | 115.13 | 11.56 |        |        |
| Dislike                                             | 18    | 3.4    | 4     | 18.2   | 98.14  | 20.24 |        |        |
| Gains from HFS learning                             |       |        |       |        |      |      |        |        |
| As role-players                                     | 366   | 68.7   | 15    | 68.2   | 122.7  | 14.35 | 1.74   | .18    |
| As observers                                        | 34    | 6.4    | 4     | 18.2   | 121.17 | 17.51 |        |        |
| The same as role-players to observers                | 133   | 24.9   | 3     | 13.6   | 119.89 | 15.62 |        |        |

*Note. HFS = high-fidelity simulation.*

\(^*\)\(p < .05\).
General Comments on the High-Fidelity Simulation Experience: Both Positive and Negative

The overall learning effectiveness score in this study was 121.81 ± 14.93. Over 70% of the participants reported a high level of satisfaction and positive feelings toward HFS learning, with phrases such as “good, very good”; “interesting, vivid, practical, funny, exciting”; “it helped linked theory to practice”; and “active learning” frequently expressed.

The participants gave Item 10 (“Discussion with the teacher after class assisted my achieving the learning goals,” 4.19 ± 0.70) the highest average score and gave Item 2 (“I understand the objective and evaluation requirements of this course,” 3.56 ± 0.73) the lowest average score. The descriptive results of SLEI-SCM are shown in Table 3.

Table 3
Chinese Undergraduate Nursing Students’ Response on SLEI-SCM (N = 533)

| Factor/Item                                                                 | Mean | SD  |
|----------------------------------------------------------------------------|------|-----|
| **Debrief (score range: 4–20)**                                            |      |     |
| 10. Discussion with the teacher after class assisted my achieving the learning goals. | 4.19*| 0.70|
| 9. The feedback provided by the teacher was immediate and promoted my learning outcome. | 4.13*| 0.71|
| 8. The teacher provided appropriate positive feedback according to the learning situation of students. | 4.12 | 0.73|
| 11. Feedback and discussion of the simulation assisted me in correcting my mistakes and promoting my learning. | 4.11 | 0.72|
| **Clinical ability (score range: 5–25)**                                   |      |     |
| 15. Situational learning enabled me to acquire useful knowledge about clinical practices. | 4.12 | 0.71|
| 14. Situational learning contributed to my mastering the processes of clinical care. | 4.11 | 0.72|
| 12. Situational learning enhanced my understanding of patient problems. | 4.08 | 0.73|
| 16. The contents of situational learning corresponded to my previous learning experience. | 4.05 | 0.71|
| 13. Situational learning promoted my ability to care for patients. | 3.90 | 0.81|
| **Problem solving (score range: 10–50)**                                   |      |     |
| 22. Simulation learning enabled me to identify problems in clinical care that I have not noticed before. | 4.16*| 0.72|
| 30. During the interaction in the situational simulation, I was willing to share workload with other team members. | 4.10 | 0.75|
| 28. Situational simulation practice provided opportunities to practice communicating and cooperating with other members in my team. | 4.10 | 0.73|
| 29. Situational simulation practice enabled me to understand the role that I should play in an interaction with a medical team. | 4.07 | 0.74|
| 25. In participating in simulation learning, I approached solutions to problems through data search. | 4.06 | 0.71|
| 26. In participating in a situational discussion, I identified solutions to problems by understanding argument to topics. | 3.98 | 0.73|
| 27. Simulation courses promoted my problem-solving skills in confronting patient problems. | 3.98 | 0.71|
| 24. Simulation learning enabled me to learn previously unfamiliar learning methods. | 3.97 | 0.76|
| 31. I could discuss patient needs with the medical team by using effective communication skills. | 3.94 | 0.78|
| 23. In participating in simulation learning, I approached new concepts or ideas through observation. | 3.91 | 0.76|
| **Resource (score range: 4–20)**                                           |      |     |
| 5. The equipment and resources for situational exercises contributed to my learning. | 3.97 | 0.70|
| 4. The equipment and resources for situational exercises were sufficient. | 3.83 | 0.80|
| 6. Using the environment and equipment for situational exercises was convenient. | 3.65 | 0.83|
| 7. If I experienced problems or difficulty using the equipment, help was always available. | 3.58*| 0.81|
| **Course (score range: 3–15)**                                             |      |     |
| 3. The activities in this course assisted my achieving the learning goals. | 3.84 | 0.70|
| 1. The course contents were arranged adequately in terms of sequential order and depth, facilitating my learning. | 3.78 | 0.74|
| 2. I understand the objective and evaluation requirements of this course. | 3.56*| 0.73|
| **Confidence (score range: 5–25)**                                         |      |     |
| 17. Situational simulation practice encouraged me to confront future clinical challenges. | 3.83 | 0.83|
| 19. Simulation learning boosted my confidence in handling future clinical problems. | 3.74 | 0.84|
| 18. Situational simulation practice boosted my confidence in my clinical skills. | 3.73 | 0.89|
| 21. Simulation learning contributed to my confidence in future patient care. | 3.64 | 0.86|
| 20. Simulation learning alleviated my anxiety/fear of confronting future clinical patient problems. | 3.61*| 0.90|
| **Total score (range: 31–155)**                                           |      |     |
| Total score                                                               | 121.81 | 14.93|

Note. SLEI-CM = Mandarin Chinese version of the Simulation Learning Effectiveness Inventory.
*The three greatest score of items. **The three lowest score of items.
The qualitative data also revealed the limitations of simulation learning with regard to authenticity and complexity. Most of the participants expressed that the situation was inadequately realistic when using the high-fidelity simulator and that they did not perceive themselves as real clinical nurses during the simulation: “No, I just had the feeling of performance thinking about what the teacher would ask, and never regarded myself as a real nurse really caring about how to care for a patient. It was a mechanical performance, and I was confused and did not get into it. Our performance cannot reflect reality and focuses more on the practical skills. Even our pre-class review only prioritized the practices. But the teacher paid more attention to how to deal with problems” (19).

Moreover, the participants expressed that the positive takeaways of the observers were less than those of the actors: “The observers may not be overly concerned with others sometimes. It was the case that they would watch the performances leisurely and did not do a lot of preparation before class because they did not need to perform” (6).

Debriefing

Debriefing was the factor that earned the highest average score for perceived simulation learning effectiveness (16.54±2.29). The average scores of the four items under the debriefing factor were each higher than 4, indicating that the debriefing plays a positive role. Similar results emerged in the interviews. Most (80%) of the interviewees perceived the debriefing as fruitful and valuable. They expressed that the debriefing session allowed them to realize their learning strengths and weaknesses and to construct a permanent and vivid body of knowledge. Moreover, the debriefing enabled them to think actively through clinical problems. Half of the interviewees advised that the duration of the debriefing could be longer to promote further discussion of the content.

“Tik me talk with my teachers and classmates after I have done all the practical training. I really like the process of finding out how to solve problems through such discussions. This kind of process helps me realize when I lack full understanding about the cases. What’s more, when I hear the perspectives of the other students who observed (a session) it makes me aware of my deficiencies and strengths in clinical practice.” (20)

Although the biggest benefits come from discussions, I prefer scenario performances during which I will think more about the problem and their solutions and the teachers will teach us how to care for patients using clinical thinking. We usually treat nursing practices separately when learning, but HFS is more systematic in that it requires many practices to link it all together, which can be the way to improve our practical skills and gain a better understanding about how to care for patients. Traditional training formats are less flexible.” (2)

Abilities

The positive feedback after HFS on the clinical abilities and problem solving of the participants is shown in Table 3. HFS was found to improve clinical nursing care abilities, as the interviewees voiced that the simulation improved their abilities in the realms of observation and analysis, communication, coping, team collaboration, and clinical/critical thinking.

“HFS teaching is a comprehensive experience that combines professional theoretical knowledge with practical skills, which will help me improve my clinical thinking and teamwork ability and strengthen our personal knowledge and skills at the same time.” (5)

“High simulation teaching can cultivate our clinical thinking and train our emergency response abilities, which helps us understand the process of clinical practice more thoroughly and may be a kind of preparation for pre-clinical work. Moreover, it provides us with a clinical atmosphere and training on teamwork.” (12)

Resources

The equipment and resources of HFS contributed somewhat to learning effectiveness (15.02±2.38). However, the participants were generally unfamiliar with the simulation equipment. For example, they were unsure of the manikin’s capabilities and did not know where to obtain needed supplies or how to use some of the equipment (e.g., patient monitor): “Some of the equipment used in HFS is different from what we usually use, and so is not very familiar to us, which leads us to panic” (10) and “We hope the equipment and models in the laboratory will be thorough. We expect that teachers can show us instructions on how to use the (less familiar) clinical equipment before the HFS activities” (17).

In addition, the participants stated that they were at a loss and felt anxiety when the teachers set up certain obstacles during the HFS activities and when, during preparation activities, the simulation scenarios unfolded differently than expected: “Sometimes there exist discrepancies between what you think should take place and what teachers deem should happen in a given scenario” (21).

Course Arrangement

The scores for the course arrangement factor and its three items indicate that the contribution of course arrangement
on learning effectiveness is not consistently positive. In the interview, the participants described that the time given to prepare and gain familiarity with the simulation environment could be longer than currently allowed and include extensions such as providing opportunities to practice in a simulation laboratory. Most of the participants (70%) suggested that the course schedule and allocation of subgroups could be rearranged to better meet students’ learning needs and should not be held during the semester immediately before clinical placement. Moreover, the participants expressed hopes of increasing the frequency of simulation-based training within the curriculum to gain greater insight on different clinical issues and knowledge.

However, the curriculum was always arranged close to the end of the semester. It’s too late for some people to prepare. (7)

I think it’s not suitable to arrange students in advance for high simulation. Teachers can assign the scripts of high simulation to the class and can pick students randomly, so that students can cooperate on the spot. As it is, only the pre-arranged actors will think through the case seriously, while the students who are observers seldom think about it. (22)

I hope HFS can imitate clinical practice better. For example, the teacher can give us the case and practice instructions for the first time, which is reasonable, and the next time we can design them on our own. I still hope that the HFS can be more challenging, containing fewer tips so that we can figure out what to do by ourselves. Even the practice instructions should be prepared on our own in advance. (14)

Confidence

Confidence received the lowest average score of all the simulation learning effectiveness factors (18.56 ± 3.67). The average scores for each of the five items constituting the confidence factor was less than 4. For example, the average score for Item 20, “Simulation learning alleviated my anxiety/fear of confronting future clinical patient problems,” was 3.61 ± 0.90. However, the interviewees reported that observing and undertaking practice in simulated scenarios, and receiving feedback and conducting discussions in a supportive environment, allowed them to build confidence to confront future clinical challenges and undertake future patient care. Some also noted that their uncertainty and worry had diminished.

HFS teaching provided us with an opportunity to practice communicating with future clinical patients, and it could be helpful for us to become familiar with the clinical nursing process. Simulated exercises reduce my fear of facing patients in the future and enhance my abilities to communicate and cooperate with other group members. (2)

HFS can improve our ability to observe practices, and we will be more relaxed when we face people, which was something we could not deal with ordinarily. (10)

After HFS practice, I felt more confident in the later clinical internship practice because it wasn’t my first time doing it. (1)

The Influencing Factors of Learning Effectiveness

Significant differences in the various independent variables affecting HFS learning effectiveness found in this study are shown in Table 2. These variables include whether the student was a class leader, personal motivation to join the nursing profession, personality type, and HFS learning preference (p < .05). On the basis of the results shown in Table 2, these independent variables were included in the regression model.

As shown in Table 4, two influencing factors, namely, enjoyment of HFS learning and having an extroverted/mixed personality type, were found in this study to be predictors of learning effectiveness. These two factors accounted for 29.0% of the total variance (F = 54.79, p < .001, adjusted $R^2 = .29$) in learning effectiveness scores. In addition, the interview results confirmed the significance of these two factors as predictors.

Discussion

To our best knowledge, this was the first mixed-methods study to provide an overview of simulation learning experiences and effectiveness in undergraduate nursing students. In this study, the qualitative and quantitative data were analyzed and interpreted using the Jeffries simulation framework, which is commonly used to guide the process of designing, implementing, and evaluating simulations in nursing facilities (Jeffries & Rogers, 2007). The findings of both the cross-sectional survey and the interviews revealed that the simulation learning effectiveness levels of the participants were only moderately high and in need of improvement. Furthermore, the findings offer critical insights for developing...
new and effective strategies to support and enhance HFS teaching.

As simulation opens door for nursing students to experience today’s most complex and challenging clinical cases early in their nursing training, it has the potential to substantively change nursing education. In the sample used in this study, the average SLEI-SCM score was 121.81 ± 14.93, highlighting the positive contributions of HFS. The moderately high simulation learning effectiveness of Chinese nursing students was particularly strong in the dimensions of “debriefing,” “clinical abilities,” and “problem solving.”

The Remarkably High Manifestation of Simulation Learning Effectiveness

Debriefing is not only the “the heart and soul” of the HFS teaching session but also a strong predictor of the efficacy of HFS teaching (Lestander et al., 2016). This finding in this study echoes those of other studies (Jacobs, 2017; Tawalbeh & Tubaisht, 2014; Tuzer et al., 2016) that found evidence in support of the positive effects of video-assisted debriefing educational experiences. In this study, faculty-led supportive, structured debriefing sessions combined with the viewing of recorded video immediately after simulation helped facilitate reflection-on-action and subsequent emotional and cognitive processing in students over time, allowing students to reflect on their responsibilities and actions, realize their mistakes/drawbacks, notice details that may have been overlooked, and learn to apply knowledge gained in different clinical scenarios. Further research is necessary to explore the effects of different debriefing methods (e.g., multimedia debriefing, self-debriefing, and in-simulation instructor-facilitated debriefing) on learning outcomes.

Clinical abilities are the ability and skills necessary for nurses to care for patients with clinical problems (Niu et al., 2014). In line with Kolb’s experiential learning theory, HFS teaching provides a learning experience that combines seeing, listening, and touching (Kolb, 1984). Echoing previous findings (Niu et al., 2014; Yuan et al., 2012), we found that HFS activities train the resourceful clinical abilities of participants. The HFS activities allowed the nursing students in this study to integrate theoretical knowledge and a range of skills into practice, including observation, communication, coping, and team collaboration in realistic simulation scenarios. Hence, the participants learned how to identify appropriate ways to solve clinical problems, which establishes a strong basis for future clinical placement. However, questions remain regarding the transferability of competence and knowledge shown in a simulated setting to actual clinical settings, which is an issue that should be studied further using longitudinal/experimental research.

The Relatively Low Manifestation of Simulation Learning Effectiveness

The findings of this study also indicated that nursing students’ simulation learning effectiveness with regard to course arrangement and equipment resources was also relatively low. Related problems included inappropriate course time arrangement, inadequate preparation time for HFS activities, and unfamiliarity with the simulation equipment, indicating that the design and conduct of HFS should be improved using several strategies, as subsequently described, to achieve the objectives and effects of HFS courses. First, scenarios for HFS may be selected based on specific course goals, the authenticity and extensibility of scenarios, and the previous learning experience of students. Second, before class, students may be provided adequate preparation time to become familiar with the simulation environment, simulator, and related equipment and resources. It should also be ensured that resources and equipment are adequate, properly functioning, and sufficiently designed to approximate the clinical experience. Third, facilitators may encourage students to freely discuss their HFS experiences and create a supportive and safe environment to enhance their confidence. On the basis of students’ learning needs and course goals, teachers should set up the most appropriate and targeted interferences or obstacles during HFS activities. If possible, students may be provided an opportunity to first watch the practices of HFS activities of teachers, which may facilitate a more thorough understanding of the learning goals beforehand and enhance student confidence.

Similar to the findings of Yuan et al. (2012) and Zhang et al. (2014), the positive effect of HFS on the confidence of the participants was mixed. Bandura held the direct experience obtained by an individual during training to be the most influential factor on his or her confidence (Bandura, 1977). The low scores for confidence may be explained by the following reasons based on the interviews and our existing knowledge. First, the participants may have perceived that the METIman was not sufficiently similar to a real human being, so they could not put themselves into a realistic mindset in the scenarios. Second, HFS cannot fully replicate the context of human healthcare because patients’ concerns and responses are changeable and complex. Third, the facilitators set up interferences and obstacles during HFS, which may have spurred negative emotions (e.g., anxiety, frustration) in the participants that hindered their learning and performance (Pai, 2016).

It is worth noting that degree of learning effectiveness significantly differed according to HFS learning preferences and participant personality. Compared with introverted students, extraverted and ambiverted students had higher learning effectiveness, possibly because the latter were more likely to challenge and express themselves (Huang et al., 2018) and to actively engage in clinical simulation scenarios and, consequently, achieve better learning efficacy. Echoing the findings of previous studies (Pai, 2016; Zhao & Chen, 2017), HFS-related learning preference was also an important facilitator of HFS learning effectiveness and student engagement.

Implications for Future Practice and Research

The findings of this study have implications for the education process and curriculum design. First, the question of how to
improve the positive initiative of nursing students who are either introverted or dislike HFS learning as well as of observers during the course deserves greater attention from nursing educators, especially in large class settings. Teachers may use appropriate strategies to improve positive participation rates and enhance peer learning. For example, during the simulation, observers may be required to complete a stimulated peer assessment tool (Solheim et al., 2017), students may be required to complete a paper about nursing care plans before class, or the instructor may randomly select students to participate in simulated practice in class. Second, future research into this subject should be designed to carefully examine the cost-effectiveness of implementing HFS in nursing programs, including time, space, equipment, and development/maintenance.

Study Limitations
When interpreting the results of this study, several limitations must be considered. First, the sample was confined to one region of Mainland China, of which may limit the generalization of the findings to other universities or countries. Second, comparisons of traditional teaching strategies and HFS teaching and a long-term follow-up of simulation learning effectiveness were not explored. To better understand the efficacy and changes of learning effectiveness during the HFS course, experimental and longitudinal study approaches should be considered in future studies.

Conclusion
This mixed-methods study provides an overview of simulation learning effectiveness among Chinese undergraduate nursing students. The participants showed moderately high HFS learning effectiveness, particularly in the dimensions of “debriefing,” “clinical abilities,” and “problem solving.” However, there remains room for improvement, particularly in areas such as equipment resources, course arrangement, and student confidence. Therefore, efforts to improve the educational process and curriculum design of HFS activities should be targeted toward these areas. On the other hand, the personality and course preferences of students should be assessed and considered.

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