Does theme game-based teaching promote better learning about disaster nursing than scenario simulation: A randomized controlled trial

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A B S T R A C T

Background: With the development of information technology, game-based teaching has continuously attracted the attention of nursing educators. It has been proven that games, as an auxiliary tool of traditional teaching, can improve students' learning motivation and learning effects. However, compared with the traditional scenario simulation teaching, whether game-based teaching has obvious advantages is still unknown.
Objectives: This study aimed to explore whether theme game-based teaching is more effective than scenario simulation in improving students' disaster nursing competency.
Design: A randomized controlled trial.
Setting: The study was conducted at a provincial vocational college in Xiaogan, Hubei, China.
Participants: A total of 104 sophomore nursing students (intervention group = 51, control group = 53) participated.
Methods: After the participants were randomly assigned to the intervention group or control group, disaster-themed games were used in the intervention group, while multi-station disaster simulation was applied in the control group. Pre- and post-tests were conducted to assess the participants' disaster nursing competence using the Questionnaire of Disaster Rescue Ability.
Results: After the intervention, disaster nursing competence levels were significantly higher in the intervention group than in the control group (4.04 ± 0.43 vs. 3.77 ± 0.45, $P = 0.002$). Three domains of disaster nursing competence, cognition (4.05 ± 0.56 vs. 3.75 ± 0.48, $P = 0.004$), skill (3.88 ± 0.50 vs. 3.62 ± 0.53, $p = 0.008$) and affective response (4.25 ± 0.42 vs. 4.02 ± 0.48, $P = 0.010$), were also significantly higher in the intervention group.
Conclusions: Compared with scenario simulation, theme game-based teaching is more effective in improving the disaster nursing competence of nursing students.

1. Introduction

Disasters are often accompanied by casualties and epidemics, which dramatically increase the health care needs of individuals, families and populations (Sasaki et al., 2020). As the largest labour force in the healthcare field, nurses play a pivotal role in disaster relief (Labrague et al., 2018). Therefore, every nurse should have basic knowledge and skills in disaster nursing and be prepared to actively respond to disasters (Park and Kim, 2017). Because disasters have a strong situational nature, traditional nursing education approaches focus on the transmission of knowledge, but it is difficult to improve students' disaster

management ability through knowledge application (Yu et al., 2018). One of the main problems of disaster nursing education is the gap between knowledge and practice (Ranse et al., 2014). With the development of educational and information technology, scenario simulations and games have been used to improve the effect of disaster nursing education (Cicero et al., 2018; Jonson et al., 2017).

Scenario simulation teaching can provide students with real scenarios, allowing them to practice and apply knowledge in a safe environment (Bryant et al., 2020), which can effectively improve their knowledge and clinical skills and enhance their self-confidence (Cant and Cooper, 2017; Lee et al., 2020). In disaster nursing education,

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students have very few disaster experiences, and their imagination of disasters is limited (Kim and Lee, 2020). Davis et al. (2020) used NLN/Jeffries simulation theory to develop, implement and evaluate four disaster scenarios that helped students learn how to triage, assess and manage wounded personnel and improved their disaster nursing knowledge and disaster preparedness. In a high-fidelity simulation activity, nurses' awareness of disasters also improved significantly (Unver et al., 2018). Students who play the wounded are often overlooked. However, a qualitative study found that disaster simulation also has a positive impact on embedded participants (Kose et al., 2020).

Game-based teaching uses game elements to enhance students' learning motivation, thereby promoting their acquisition of knowledge and skills (Garris et al., 2002). In recent years, games have aroused extensive research interest in nursing education (Gallegos et al., 2017). The existing evidence shows that games can enhance learning outcomes (Kinder and Kurz, 2018; Wingo et al., 2019). Kinder and Kurz (2018) used the kahoot.it game in the classroom and found that students' final exam scores significantly improved. Wingo et al. (2019) found that the online educational game Kaizen can enhance students' knowledge retention and learning skills. However, previous research has focused mainly on students' game learning experience. For example, the results of a previous disaster nursing course study showed that students had a strong interest in the game content and believed that games helped them learn better (Hung et al., 2020). In another disaster training study, the escape room game created a positive learning experience for students and enhanced their understanding of the mass casualty incident (MCI) and teamwork (Wood and Abernethy, 2020). Few studies have investigated the role of games in improving students' disaster nursing competence except in training in certain disaster skills, such as CPR, yet serious games have effectively improved students' learning acquisition scores and skill performance (Boada et al., 2015).

Scenario simulation and game-based teaching have certain qualities in common, and most games have been developed and designed on the basis of simulation technology. However, there is a clear difference between the two (Koivisto et al., 2017). A game is an artificial educational tool that includes conflicts, rules and predetermined goals, while a simulation is a dynamic tool that represents reality and claims fidelity, accuracy, and validity (Sauvé et al., 2007). Recently, game-based teaching has continuously attracted the attention of nursing scholars, so it is worth studying whether it has obvious advantages over traditional simulation teaching (San Martín-Rodríguez et al., 2020). Therefore, the aim of this study is to compare the effect of theme games and scenario simulations on the disaster nursing competence of nursing students.

2. Methods

2.1. Study design

This prospective randomized controlled study compared pre-test and post-test results to explore whether theme game-based teaching is more effective than scenario simulation teaching in improving participants' disaster nursing competency. Computer-based software for random number generation was used to randomly assign the participants to either the intervention group or the control group. The study design conformed with the CONSORT guidelines (Schulz et al., 2010). To prevent bias, the group allocations were not disclosed to the participants.

2.2. Study participants and setting

The participants were recruited from a provincial vocational college in Xiaogan, Hubei, China, through online recruitment advertisements inviting nursing students to participate in the study. Eligible students were sophomore nursing students who (a) had studied in the school for at least a year, (b) had completed 16 class hours of disaster nursing

theory and skills training, and (c) signed a consent form. The study participants and settings are shown in Fig. 1.
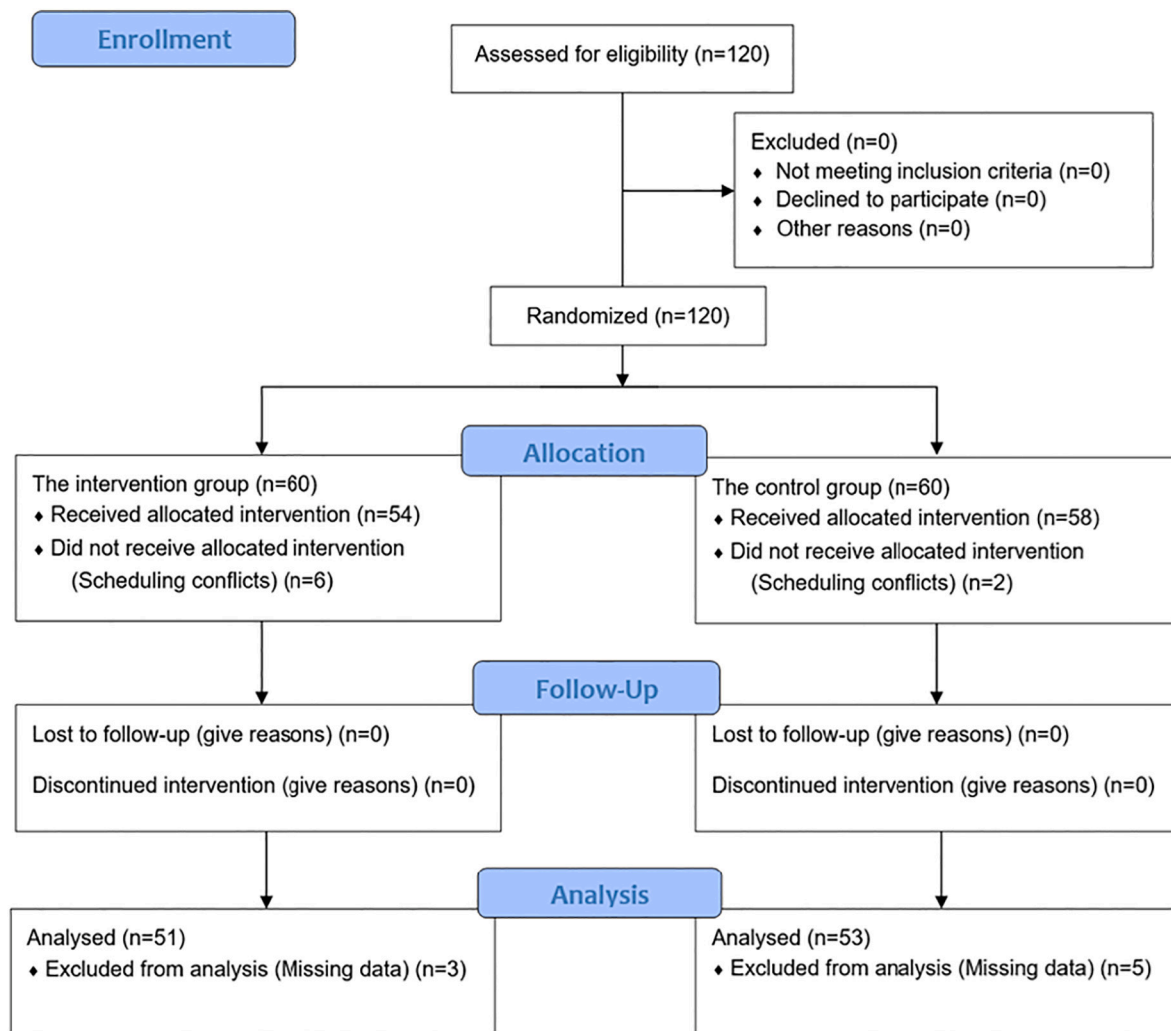
2.3. Interventions

Based on the ICN Framework of Disaster Nursing Competencies (World Health Organization [WHO] and International Council of Nurses, 2009) and flow theory (Csikszentmihalyi, 1990), we developed a theme game called "*Brave the Wind and Wave*". It covered four aspects of disaster nursing competence, and the difficulty matched the subjects' level of cognition and skill. The learning objectives are shown in Table 1. The "*Brave the Wind and Wave*" theme game was played in five sessions: (a) Forewarned is forearmed: Develop and implement a disaster skills training programme for third grade students; (b) When an earthquake strikes: Prepare medical and health resources for rescue at the earthquake site; (c) Race against time: Triage, rescue and handling of five injured people in a disaster-affected community; (d) Comfort the soul: Evaluate and intervene in the psychological stress response of wounded family members; and (e) Eliminate hidden dangers: Provide post-disaster health and epidemic prevention education to community residents. The contents of the programme are shown in Table 2. The game was designed for the intervention group and was played in a simulated training room. Before the start, 51 students were divided into six groups, with 8–10 students in each group. According to the progress of the game, the researchers used the computer to manipulate the contents and tasks and set scenes for the students. Game elements such as cooperation, gut scenes/stories, competition, resource management, question/answer, time pressure, and feedback were used.

For the control group, we adopted the most common multi-station disaster simulation method in China. There was a total of 53 students in the control group and 8–10 students in each group. According to the learning objectives (Table 1), each group of students was required to review disaster nursing knowledge and skills, and then completed the simulation cases of five sites: (a) Triage: Assess and triage the injuries of five wounded people in the form of a tabletop exercise; (b) Haemorrhagic shock: Rescue the wounded suffering from haemorrhagic shock; (c) Trauma and bandaging: Evaluate and deal with an injured person who is bleeding from a right upper limb injury incurred in the earthquake; (d) Fracture fixation: Assess and deal with a patient with a fracture of the left leg; (e) Carrying: Carry a wounded person with a spinal injury to a temporary treatment point. The structure of each simulation was: pre-review, case presentation, simulation and structured group debriefing. A summary was used to evaluate the students' performance at the end of all simulations.

2.4. Measurement tools

A demographic questionnaire designed for the purpose was used to collect relevant information, including age, gender, single-child status, family location, and experience of disaster and rescue.

The Questionnaire of Disaster Rescue Ability was developed in China to assess the disaster nursing competence of nursing students (Wang and Jin, 2018). The questionnaire contains 33 items in three dimensions: cognition (10 items), skills (14 items) and affective response (9 items). Each item is rated on a 5-point Likert scale ranging from 1 ("strongly agree") to 5 ("strongly disagree"). The questionnaire adopts the reverse scoring method and calculates the average score of the total questionnaire and each dimension, with higher scores indicating higher disaster nursing competence. The total Cronbach's α coefficient of the questionnaire was 0.951, and the Cronbach's α coefficients of the three dimensions of cognition, skills and affective response were 0.892, 0.916 and 0.866, respectively. The total Gretman's half coefficient was 0.851, and the Gretman's half coefficients of the three dimensions were 0.813, 0.874 and 0.806, respectively (Wang and Jin, 2018).

1. 1. Flow chart of participants in the randomized controlled experiment.

2.5. Data collection procedure

All participants completed the demographic questionnaire and the Questionnaire of Disaster Rescue Ability before the intervention (pre-test). The intervention group participated in the theme game named "*Brave the Wind and Wave*" with earthquake disaster as the background. The control group participated in the multi-station disaster scenario simulation. All participants were evaluated by the Questionnaire of Disaster Rescue Ability after the intervention (po*st*-test).

2.6. Statistical analysis

The Statistical Package for Social Sciences Version 21.0 (SPSS 21.0) was used for data analysis. The chi-squared test was used to compare the equivalence of demographic characteristics between the two groups. The independent samples t-test was used to explore differences in disaster nursing competency levels between the two groups.

2.7. Ethical considerations

This study was approved by the research ethics committees of Wuhan University School of Health Sciences and the vocational college. Before the study, the researchers obtained informed consent from each participant, and the participants had the right to withdraw from the study at any time. To protect the privacy of the participants, all questionnaires were filled out anonymously, and the researchers kept all data confidential. To ensure that participants would not feel intimidated or threatened, teachers at the school did not participate in the research.

3. Results

A total of 112 participants completed the study and completed the self-rating scale for disaster nursing competence. A total of 112 questionnaires were collected, of which 8 were invalid. Ultimately, 104 participants were included, with 51 in the intervention group and 53 in the control group. The age of the students ranged from 18 to 22, with a mean of 19.19 (SD = 0.78). Among the 104 students who participated in the study, most were female (83.7%). Fig. 1 shows the flow of study participants.

No significant differences in student demographics (i.e., age, gender, single-child status, location of the family), or experience of disaster and rescue were observed between the intervention group and the control group (Table 3).

3.1. Comparing differences in the disaster nursing competence level between the two groups

The independent samples *t*-test was used to examine differences in disaster nursing competence between the two groups (Table 4). The results showed that the mean score on the Questionnaire of Disaster

Table 1
Learning Objectives of Intervention group and Control group.

Domain	Intervention group	Control group
Cognitive	• List the medical and health resources commonly used in disaster rescue and explain their use; • Apply principles and procedures of disaster rescue; • Carry out health education of epidemic prevention after disasters.	• State the definition of disaster and disaster nursing; • State the principles, procedures and points of disaster rescue; • State the key points of environmental health management in disaster areas.
Skills	• Rapid triage of the wounded people; • Rational use of medical and health resources, and implement common disaster care techniques; • Observe the changes of the wounded's condition in time and take corresponding nursing measures; • Provide psychological care for people with psychological problems after the disaster; • Have a clear communication with the wounded; • Use correct terminology with rescuers.	• Rapid triage of the wounded people; • Rational use of medical and health resources, and implement common disaster care techniques; • Observe the changes of the wounded's condition in time and take corresponding nursing measures; • Discover the wounded's psychological problems and provide psychological care; • Have a clear communication with the wounded; • Use correct terminology with rescuers.
Affective	• Actively integrate into the disaster rescue environment; • Actively communicate and collaborate with team members; • Experience the inner feelings and emotions of the wounded people and keep loving, patient, careful, and responsible.	• Actively integrate into the disaster rescue environment; • Actively communicate and collaborate with team members; • Experience the inner feelings and emotions of the wounded people and keep loving, patient, careful, and responsible.

Rescue Ability significantly increased in both the intervention group and control group: the intervention group increased from 3.38 to 4.04, and the control group increased from 3.29 to 3.77. However, the total average score in the intervention group was significantly higher than that in the control group after the intervention ($p = 0.002$).

3.2. Comparing the three domains of disaster nursing competence between the two groups

The independent samples t-test was used to examine differences in the three domains of disaster nursing competence between the two groups (Table 5). The results showed that the average scores of the three domains were significantly higher in the intervention group than in the control group: cognition (4.05 ± 0.56 vs. 3.75 ± 0.48, $p = 0.004$), skill (3.88 ± 0.50 vs. 3.62 ± 0.53, $p = 0.008$), and affective response (4.25 ± 0.42 vs. 4.02 ± 0.48, $p = 0.010$).

4. Discussion

The study explored the impact of theme games and scenario simulation on the disaster nursing competence of nursing students and found that the overall score of disaster nursing competence and the scores of the three dimensions (cognition, skills, and affective response) of theme game-based teaching were significantly higher in the theme game-based teaching group than in the scenario simulation teaching group ($P < 0.05$).

According to self-determination theory, gamification, as an intermediary force, can meet the basic social and psychological needs of learners (competence needs, autonomy needs and relatedness needs), help learners internalize motivation, and improve their learning effects (Rutledge et al., 2018). In our study, we divided the teaching process

Table 2
Contents of the "Brave the Wind and Wave" game programme.

Main programme (110 min)

1. Forewarned is forearmed (35 min)
Contents

• Develop and implement a disaster skills training programme for third grade students.
Assignments

• Complete the training task within 30 min
• Answer the teacher's questions
Rules

• When the students cannot complete the whole training task, the teacher has the right to guide them to redesign and carry out the training task.
• When the students fail to answer questions from the "primary school students", they are allowed to use their mobile phones to seek online help.

2. When an earthquake strikes (15 min)
Contents

• Prepare medical and health resources for rescue at the earthquake site.
Assignments

• Before students go to the disaster area, they need to prepare relief supplies. All the materials have been placed in different corners of the simulation room. They have to select the ten most important medical and health materials to be used in the next rescue within 10 min.
• Answer the teacher's questions about the reasons for choosing their materials and the uses of the materials they chose.
Rules

• Students are allowed to use network resources to screen substances on site.

3. Race against time (20 min)
Contents

• Triage, rescue and handling of 5 injured people in a disaster-affected community.
Assignments

• Within 5 min, five injured people need to be classified according to the START triage method.
• According to the classification results, the students apply reasonable rescue and treatment measures for the wounded within 10 min. These include cardiopulmonary resuscitation, airway management, haemostasis, bandaging, and fracture fixation.
• Transport injured persons to temporary medical treatment points for further treatment within 5 min.
Rules

• When the medical and health resources obtained in the previous game session do not meet the needs of rescue, the students are allowed to use some life materials in the simulated classroom as relief materials.

4. Comfort the soul (20 min)
Contents

• Evaluate and intervene in the psychological stress response of wounded family members.
Assignments

• A student is selected to conduct psychological assessment and intervention for Mrs. Li within 20 min based on this background: Mrs. Li's son died in the earthquake. She is very sad, crying every day and losing sleep every night.
• Flexibly deal with the various problems of Mrs. Li.
Rules

• Students can use electronic devices as auxiliary tools to carry out psychological interventions with Mrs. Li.
• When the participant is unable to deal with Mrs. Li's various problems flexibly, she/he is allowed to seek assistance from his/her companion (psychotherapist), but this opportunity is available only once. If his/her companions still cannot solve these problems, the task challenge is a failure. After the teachers give guidance, the task will restart.

5. Eliminate hidden dangers (20 min)

Table 2 (*continued*)

Contents

- Provide post-disaster health and epidemic prevention education to community residents.

Assignments

- A participant teaches Mrs. Wang about hygiene and epidemic prevention within 20 min based on this background: many people have diarrhoea due to the use of contaminated food as a result of the earthquake.
- Flexibly deal with the various problems of Mrs. Wang.
- Assess and eliminate health hazards in Mrs. Wang's home.

Rules

- Two students should use easy-to-understand language to achieve the purpose of the exercise.
- If they cannot answer Mrs. Wang's questions correctly, they fail in the challenge. Under the guidance of other peers and teachers, the game is restarted.

* The team includes 1 team leader, 1 doctor, 3-4 nurses and 2-3 volunteers.

* Students must complete the task within the specified time before entering the next stage of the game

Table 3

Sociodemographic characteristics of the participants ($N = 104$).

		Intervention group($n = 51$)	Control group($n = 53$)	t	p
		Mean ± SD	Mean ± SD		
Age		19.22 ± 0.757	19.17 ± 0.802	0.300	0.765
		N (%)	N (%)	X^2	P
Gender	Male	7 (13.7)	10 (18.9)	0.503	0.478
	Female	44 (86.3)	43 (81.2)		
Single-child status	Yes	14 (27.5)	19 (35.8)	0.846	0.358
	No	37 (72.5)	34 (64.2)		
Location of the family	Urban	10 (19.6)	12 (22.6)	0.143	0.705
	Rural	41 (80.4)	41 (77.4)		
Whether experienced a disaster	Yes	25 (49.0)	23 (43.4)	0.331	0.565
	No	26 (51.0)	30 (56.6)		
Whether experienced disaster rescue	Yes	3 (5.9)	1 (1.9)	0.302	0.583
	No	48 (94.1)	52 (98.1)		

Table 4

Comparison of disaster nursing competence for sample of nursing participants ($N = 104$).

	Intervention group (n = 51)		Control group(n = 53)		t	p
	Mean	SD	Mean	SD		
Before intervention	3.38	0.40	3.29	0.38	1.164	0.247
After intervention	4.04	0.43	3.77	0.45	3.114	0.002

Table 5

Comparison of the three domains of disaster nursing competence ($N = 104$).

	Intervention group (n = 51)		Control group(n = 53)		t	p
	Mean	SD	Mean	SD		
Cognition						
Before intervention	3.30	0.50	3.18	0.45	1.324	0.189
After intervention	4.05	0.56	3.75	0.48	2.981	0.004
Skill						
Before intervention	3.23	0.47	3.08	0.47	1.588	0.115
After intervention	3.88	0.50	3.62	0.53	2.688	0.008
Affective response						
Before intervention	3.70	0.45	3.74	0.48	−0.444	0.658
After intervention	4.25	0.42	4.02	0.48	2.618	0.010

into five sessions. Each session goal was challenging but achievable, which fully stimulated the students' engagement, knowledge and skills mastery. The results were consistent with a study of Mokadam et al. (2015) that used game elements to pre-set "winning" goals for the courses and encouraged students to use simulators to improve their professional skills. In our study, a multi-station scenario simulation was also designed for each station with learning tasks but no assessment, which is a common disaster nursing simulation mode in China (Xia et al., 2016). The students improved their disaster competence by completing the teaching task. However, the scores of self-rated knowledge and skills of the control group were lower than those of the intervention group, which may be related to the improvement of students' intrinsic motivation in achieving the goal of the theme game (Gómez-Urquiza et al., 2019). In addition, compared to the psychological feeling of insecurity experienced by students in the practice of scenario simulation (Kang and Min, 2019), games could provide students with a pleasant and relaxing learning and practising environment. Especially in disaster nursing education, this approach could improve nursing students' learning experience in scenario simulation teaching and further improve their knowledge and skills (Hung et al., 2020).

Affective factors are often overlooked in teaching and assessment, with more emphasis placed on cognitive and skill factors (Tshikanda, 2020). Disasters are characterized by suddenness and continuity. In different stages of a disaster, the roles and tasks of nurses are significantly different. Especially in the emergency response stage, the role of nurses has undergone a significant change in that that they face affective challenges to their personal, professional and environmental boundaries (Hugelius and Adolfsson, 2019). As experiential teaching, games and scenario simulation enhance learners' attitudes, values and beliefs in the affective domain (Despeisse, 2018; Holt, 2017). In our study, the self-evaluated emotional score of the intervention group was significantly higher than that of the simulation group (p < 0.05). Compared with the fixed mode of scenario simulation teaching, game-based teaching is an open education mode in which students are given more autonomy, which provides them with opportunities to deal with different information simultaneously (Solinska-Nowak et al., 2018). In addition, participants have a more continuous and complete role experience in gamification teaching (Young, 2018). Through durative emotional connections with game characters, students develop the ability to flexibly respond to various difficulties and the changing roles that are emotionally required during competence training.

With the continuous development of information technology, more games are being used in nursing education, but the development and application of electronic games requires a high cost that is burdensome for many universities (Freire et al., 2016). In this regard, many traditional games, such as the "Nursing Escape Room" (Morrell et al., 2020), have been continuously promoted and studied in recent years (McEnroe-Petitte and Farris, 2020). The disaster nursing-themed game in this research was developed on the basis of universal teaching equipment, which could reduce the financial pressure of vocational colleges, maximize the advantages of theme game-based teaching, and improve students' disaster nursing learning effects. Although this does not mean that the teaching effect of theme games is better than that of scenario simulation in all nursing courses, the findings provide significant reference value for nursing education.

5. Limitations

This study has several limitations. It employed convenience sampling to select students from a vocational college in China, so the results might not be generalizable to all nursing students. In addition, the measurement used in this study was a self-reported questionnaire, which may introduce certain measurement errors. Finally, this study tested disaster nursing competence immediately after the intervention, but longer and repeated follow-up may lead to different outcomes, and the long-term knowledge, skills, and affective level of students should be considered

in future studies.

6. Conclusions

To the best of our knowledge, this is the first randomized controlled trial that compares game-based teaching and simulation in disaster nursing education. Compared with traditional simulation teaching, the application of theme game-based teaching can improve the disaster nursing competence of nursing students to a greater extent. Game-based teaching should be widely used in disaster nursing education. Further research can explore the application effect of theme games on different nursing student groups in other nursing courses.

CRediT authorship contribution statement

Denghui Ma: Conceptualization, Methodology, Investigation, Formal Analysis, Visualization, Writing- original draft, Writing- Reviewing and editing.

Yuxin Shi: Conceptualization, Methodology, Investigation, Formal Analysis, Visualization, Writing- original draft, Writing- Reviewing and editing.

Guai Zhang: Conceptualization, Methodology, Writing- original draft, Writing- Reviewing and editing.

Jun Zhang: Conceptualization, Methodology, Writing- Reviewing and editing.

Denghui Ma and Yuxin Shi contributed equally to this work. All authors read and approved the final manuscript.

Declaration of competing interest

None.

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