

## ORIGINAL RESEARCH

# Game-based vs. Case-based Training for Increasing Knowledge and Behavioral Fluency of Nurse Students Regarding Crisis and Disaster Management; a Quasi-Experimental Study

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**Abstract:** **Introduction:** Nurses play an active role in disaster response, and the ability of nurses to appropriately apply management principles during large-scale disasters or mass casualty incidents is of critical importance. This study aimed to compare the effect of game-based Training (GBT) and case-based training (CBT) on nursing students' knowledge and behavioral fluency regarding Crisis and Disaster Management. **Methods:** This is a quasi-experimental study with a pretest-posttest design. Convenience sampling was used to select third-year nursing students who had completed their clinical clerkship at the time of the study (n=60). In the intervention group, disaster-themed games were used, while in the control group, CBT was used. The emergency and crisis management course consisted of this study's theoretical and clinical training phases. After completion of the theoretical phase (five weeks), the practical part (four weeks) is completed as an internship. The data was collected from the disaster Nurses' Knowledge Questionnaire, demographic survey, and measurement checklists for disasters and crises at five stations. **Results:** GBT students achieved significantly higher knowledge scores than CBT students after training ( $P < 0.001$ ). CBT and GBT groups had no significant differences in Objective Structured Clinical Examination (OSCE)1 pretest scores. Posttest1-OSCE2 and posttest2-OSCE3 scores showed significant differences after one week ( $P < 0.001$ ) and one month ( $P < 0.001$ ). The difference in mean pretest and posttest1 scores was statistically significant in both groups. A comparison of posttest scores between one month after GBT training ( $69.03 \pm 6.09$ ) and one week after it ( $69.23 \pm 6.14$ ) revealed no statistical significance ( $p = 0.056$ ). **Conclusion:** Nursing students' knowledge and behavioral fluency regarding crisis management were more effectively improved by using the disaster and crisis game than by using a case-based method.

**Keywords:** Education; Games, Experimental ; Knowledge; Disaster medicine; Teaching

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## 1. Introduction

Since nurses are the largest health care workforce, they play a critical role in disaster response. Therefore, every nurse must be able to respond to disasters actively and navigate disaster care (1).

Fluent behavior is defined as accuracy coupled with speed, which is essential for decision-making during a disaster (2). There are three characteristics of fluent behavior. These are



durability (consistency over time), stability (i.e., maintaining the behavior in a distracting environment), and generalizability (generalizing to a new situation) (3, 4). It is challenging to improve students' ability to cope with disasters by applying knowledge alone because disasters are situational (5). The discrepancy between knowledge and practice in disaster nursing education is a significant problem (6), and traditional teaching methods do not prepare nursing students to deal with mass casualty incidents (7).

Meanwhile, a precision teaching framework ensures that learner performance is monitored to determine when fluency has been achieved (3). In the words of Kunzelmann (1970), "Precision teaching is not a method. It is a way of teaching" (8). Interventions that involve precision teaching typically include the following steps: 1) establishing a fluency criterion (a period during which an expert can comfortably and accurately perform the task); 2) frequency building, which involves the learner repeatedly performing the behavior and receiving feedback on it (timed learning trials); 3) using the standard celeration chart (a semi-logarithmic chart illustrating the frequency of a target behavior) to monitor progress, which illustrates whether learning gains are occurring or whether teaching tactics should be changed (3, 8).

Students in nursing education have few experiences with disasters, and their imaginations are limited (9). Technology development in the last decade has influenced how students learn by changing their learning and behavior patterns (10). Combining interactive scenarios and animated speakers can be a powerful teaching tool for disaster nursing education by combining treatment situations with technology (11). Lydon et al. (2017) reported that medical students who received simulation-based training with precision teaching to practice venipuncture performed better than their untrained peers and hospital doctors. Learning was transferable to the clinical setting, and performance was maintained during distraction and follow-up (4). Game-based instruction is believed to increase students' motivation to learn and thus promote acquiring knowledge and skills (12). In recent years, a growing body of literature has been published on the potential of games as a tool to enhance nursing education (13). However, previous research has mainly focused on students' learning experiences with games (14). This study aims to compare the effect of GBT with Precision Teaching and CBT on nursing students' knowledge and behavioral fluency regarding crisis and disaster management.

## 2. Methods

### 2.1. Study design and setting

This quasi-experimental study, with a pretest-posttest design, examined how GBT with Precision Teaching improved disaster nursing management knowledge & behavioural flu-

ency in nursing students of Torbat Heydarieh University of Medical Sciences between 2021 and 2022. Emergency and Crisis Management is one of the courses in the three-year Bachelor of Science in Nursing (BSN) degree program. The curriculum consists of 34 hours spread over nine weeks. The Emergency and Crisis Management course consisted of this study's theoretical and clinical training phases. After completion of the theoretical phase (five weeks), the practical part (four weeks) is completed in the form of an internship. The flow diagram and phases of the study are shown in Figure 1. Ethical approval for the research was obtained from the Smart University of Medical Sciences Research Ethics Committee (Ethics Code: IR.VUMS.REC.1400.028). Informed consent was obtained from all participants. They were assured that their personal information would be kept confidential and that only general statistics and data would be published.

### 2.2. Participants

Convenience sampling was used to select third-year nursing students who had completed their clinical clerkship at the time of the study (n=60). Inclusion criteria were being interested in participating in research and completing an emergency course. Participants were excluded from the study if they did not attend an educational session and did not complete the study's second phase. Using computerized random number generation software, participants were randomly assigned to either the intervention or the control group.

### 2.3. Preparation of gamified triage

We developed a theme game based on the framework of nursing competencies developed by the World Health Organization and the International Council of Nurses ([www.who.int/disasternursing/framework\\_of\\_competences\\_09.pdf](http://www.who.int/disasternursing/framework_of_competences_09.pdf)).

After a thorough study of existing software, two applications, Articulate Storyline 3 and CarzyTalk animator 4 were selected for the development of the game content and framework. Articulate Storyline 3 software is user-friendly and was developed by Articulate Global Co. It is one of the most popular applications for electronic content design. This software has been used for the development of numerous electronic contents (15-17). CrazyTalk Animator, developed by Reallusion, was the platform for creating 2D animations. This software is easy to use and provides good quality results. It has been used in several studies for storyboarding and can be considered by researchers for creating animations.

The first step in developing gamified triage was to define the functional and technical requirements, including modules, the design of a learning path, and a graphical user interface (GUI). Following this, the learning content was developed, including the information elements. Based on a triage guide



and reference materials, the information elements for the learning content were developed (18-20). Animation techniques and Articulate Storyline 3 software were used to create the interactive content. CrazyTalk Animator v4 software was used to create the text content of each slide as a female character with facial, lip, and mouth movements that appeared on each slide. To learn both the auditory and visual parts of the scenario-based section, explanations were given using animated animations. As a reward for correctly answering the scenario questions, students received 4 triage coins produced by the content production team, which were counted at the end of this section. The game consisted of 25 scenarios organized into five categories. Students could earn a total of 20 points or coins for each scenario. Students would be returned to the beginning of the game if they scored less than 86 coins. Here is a video of the designed content embedded in Google Drive: <https://zaya.io/uew1q>. 7 Nursing and Midwifery faculty members approved the scientific content of the crisis management game. In addition, two members of the Smart University of Medicine e-learning group reviewed the technical features of the content. The design of the game environment is shown in Figure 2.

#### 2.4. Data gathering

A questionnaire on demographic characteristics (age, gender, single child status, family residence, previous disaster/rescue experience, and previous participation in related training courses), Disaster Nurses' Knowledge Questionnaire, and measurement checklists for disasters and crises were used to collect data in five stations.

### 3. Procedure

#### 3.1. Preparation

Teaching precision requires identifying the target behavior, which must be determined precisely (9). To accomplish this, a written definition of the observable, physical movements of the behavior must be developed. The things we did for precision teaching include: 1- To identify and quantify the mastery of each catastrophe determined for the game, we developed task analyses that detailed the steps in the performance of each behavior. We explained the physical movements and materials required for each behavior. The task analysis involved a review of relevant clinical practice guidelines and consultation with an emergency nurse with over 20 years of experience. 2- Two senior clinicians with expertise in GBT were asked to assess and provide feedback regarding procedural skills training. They confirmed the validity of the task analysis. 3- As a result, it was decided to establish a fluency criterion. The fluency criterion was established after a clinical professor performed each station three times with 100 percent accuracy, and the mean duration of these per-

formances was used to determine the fluency criterion. This test was scored on a 100-point scale, with 20 points for each station (n=5). For each station, a fluency criterion required participants to perform the task with 100% accuracy without exceeding the expert's mean duration by more than 10%. We administered the OSCE test immediately and one month after the intervention and compared the results of each test.

Behavioral fluency, as mentioned, has three components: Durability, Stability, and Generalizability. Concerning durability, we aimed to examine whether the intervention improved the pace and accuracy of participants in each crisis management scenario. Regarding the component of generalizability or generalization to a new situation, the OSCE test was designed so that the topics of the OSCE stations were similar. However, parallel scenarios were used for this purpose so that the participant could test his or her acquired knowledge in them and show that he or she could apply it correctly in new situations with the same speed and accuracy. Also, concerning the stability component, Students' performance in disaster and crisis management was evaluated in the presence of distractions to assess the stability of their behavior. A major distractor in clinical practice is communication irrelevant to the current clinical task. Our distraction strategy consisted of interruption questions that had nothing to do with the current task (e.g., "Tell me about the last book you read"). The interruption questions were asked in a standardized order and at a standardized time.

Questions were asked at one-minute intervals, and when participants gave short answers, they were reminded to provide more information.

#### 3.2. Pretest

Participants received a brief overview of the intervention and fluency criterion in two groups in the simulation laboratory and at the OSCE stations. Each presentation of the simulated scenarios at the OSCE-1 stations in the pretest was a fluency-building trial. A trained observer observed each exercise during all tests and recorded the time.

The procedure was to end as soon as participants completed the clinical report. Participants were instructed to manage crisis situations "to the best of their ability," and one of the two trained observers was to rate the accuracy and pace of their performance. On the record sheet, the observers had to note whether each step was performed correctly or inaccurately. One observer provided corrective feedback to the participant at the end of the trial. The task analysis was given to the participants at the end of the trial.

Observers provided specific, detailed feedback to participants on the accuracy and pace of performance. The observer gave a detailed report of all steps performed incorrectly and the total number of steps performed. Those who performed incorrect steps had the opportunity to practice



them during the practical phase of the study.

### 3.3. Posttest

We conducted two posttests in the two groups after the intervention ended. The OSCE test was used to assess students' behavioral fluency and durability. The OSCE test after the intervention was administered to both groups simultaneously in two phases: one week (OSCE-2) and one month (OSCE-3) after the emergency and crisis management internship. The student's performance was assessed using a five-station OSCE each time.

The stations were designed based on five scenarios. Ten disaster management experts and faculty members confirmed the validity of the checklists. Inter-rater reliability between the two trained nursing educators with identical professional characteristics was also calculated by correlating the scores obtained by ten nursing students (who were not included in the main analysis). It was found that the ICC coefficients of agreement between the educators were 0.92, indicating substantial agreement. The stations had a scenario, a guide, an examiner guide for the assessor, an assessment checklist, and a scenario for standard patients. In each station, one or more objectives were assessed using checklists created by the researchers. Based on the objectives in each station, standard patients, mannequins, and equipment were used based on each station's objectives. A coordinating committee reviewed all stations and equipment one day before the test. Participants were told that one of two observers would rate their accuracy and performance duration.

### 3.4. Disaster Nurses' Knowledge Questionnaire

The test consisted of 15 multiple-choice questions (MCQs) on disaster preparedness, such as the definition of disasters (one item), types of disasters (two items), causes of disasters (three items), management of disasters (three items), and the role of hospital and emergency nurses in disasters (six items). According to the Nurses' Knowledge Questionnaire scoring system, each correct answer was scored one point, and each incorrect answer was scored zero points. The total score for knowledge was 15 points. The higher the score, the better the nurse's knowledge.

All participants were assessed before (pretest) and immediately after the theoretical phase of the intervention (posttest), using the Questionnaire of Disaster Nurses' Knowledge.

### 3.5. Internal consistency reliability

In the study by Khalil (2019), the reliability of the questionnaire was confirmed, and Cronbach's alpha was 0.76 (21). This study used a test-retest procedure to investigate the instrument's reliability. A Cronbach's alpha coefficient of 0.81 was calculated and reported.

## Phase 1: Theoretical training

### Intervention group

The educational intervention was conducted for five weeks in a simulated university classroom, with a game-based case each week. The researchers used computer software to modify the contents and tasks of the game and to set scenes for students based on the game's progress. There were various game elements, including cooperation, good scenes/stories, competition, resource management, questions, answers, time pressure, and feedback. The game was played in five sessions and included the following topics:

1. Preparing medical and health resources for earthquake rescue
2. Racing against time: triage, rescue, and treatment of five injured victims in a disaster area
3. Providing comfort to injured family members through assessment and intervention in their psychological stress response
4. Managing a patient with hemorrhagic shock
5. Assessing and managing a patient with a head injury

Both the intervention and control groups used similar teaching scenarios in terms of content. The instructor was also the same in both groups.

Students participated in a crisis and disaster game each week under the supervision of a clinical professor. The following steps were followed for each game. Each time, a two-hour session was scheduled and conducted with the disaster and crisis game, beginning with the student logging into the game and ending with the feedback. Access to the game was through usernames and passwords assigned to each user. Students received detailed instructions for the game from the researcher. Once they logged into the computer, they could access the appropriate section of interactive learning content in the game. The teacher monitored the students' activities, and the students received feedback on their games from the teacher.

The game development team designed individual avatars for each student, and the teacher recorded and shared the results of each student session based on the avatars. To ensure confidentiality, students did not know each other's avatars. The avatars and results were displayed on the university's Learning Management System (LMS) leaderboard as part of the competition. Students received badges for playing and learning the scenarios, and those who received more than five were allowed to participate in the clinical phase.

Twenty-four hours after working through each scenario game, the students participated in a 90-minute debriefing in the Shahidi conference room at Nohomeday Hospital in Torbat Heydariyeh. The clinical professor had attended a debriefing workshop and had the necessary experience to conduct debriefing sessions. The 3D model was used throughout the study, and all debriefing sessions followed

International Nursing Association of Clinical and Simulation Learning (INACSL) guidelines.

### Control group

In the control group, instruction was face-to-face. Each two-hour session began with a case study of disaster conditions related to the lesson topics. During the discussion of the paper-based scenario, a clinical instructor discussed the educational objectives to be achieved by working with the scenario. He also asked questions to determine the all-encompassing prior knowledge of the case. After a brief introduction to the case by the clinical professor, students began working with the scenario. Like the intervention group, the control group also received five weeks of theoretical training. Each week, a disaster and crisis scenario was presented.

### Phase 2: Clinical training Disaster & crisis internship

In this phase, the intervention and control groups were each divided into five groups of six students (10 groups of six in total).

Internships and clinical training in the university's clinical laboratories were conducted for four weeks with standardised patients and simulated emergencies and crisis situations. This phase was structured according to the four-step Pazin model for each crisis case, which includes the steps of 1) briefing, 2) sequence, 3) feedback, and 4) repetition (22). During the briefing step, the trainer explains the scenario in front of the participants. During the sequence step, progressively more complex scenarios were presented, allowing participants to consolidate their knowledge and work at a higher level of training and learning. During the feedback step, the trainer acted as a facilitator, observing participants' exercises and providing feedback as needed. Debriefing is the heart of the feedback process. The trainer designed a non-threatening environment with open-ended questions and positive reinforcement to encourage participants to participate. As a final step, the trainer ensured that the knowledge learned during the training was retained during each training session through repetition and practice. During the internship phase, participants' data (steps executed correctly, steps executed incorrectly, and execution duration) were used to create standard acceleration charts using Chartlytics software ([www.chartlytics.com](http://www.chartlytics.com)).

### 3.6. Statistical analysis

SPSS software version 16.0 was used to analyze the data and examine the effects of game-based teaching on the behavioral fluency of nursing students in disaster management courses. Shapiro-Wilk and Kolmogorov-Smirnov tests were used to examine the natural distribution of quantitative variables. Descriptive statistics such as mean, standard deviation,

and frequency distribution were used to describe participants' characteristics. Analyses were performed using inferential statistics (Repeated measures analysis of variance (ANOVA), independent t-test, paired t-test, chi-square). In this study, the significance level was considered to be  $P < 0.05$ .

## 4. Result

Sixty-three nursing students participated in this study, most of whom were single (87.3%) and female (81.7%). The Chi-square test showed that the intervention and control groups were homogeneous regarding gender. There was no significant difference in mean age between the intervention and control ( $20.75 \pm 1.16$  vs.  $20.70 \pm 1.16$ ;  $p = 0.83$ ; respectively). Most participants (86.2%) had never experienced a disaster or rescue. This was the first time participants had attended a crisis management training program.

### 4.1. Behavioral fluency

A repeated measures ANOVA was conducted to compare the fluency of the GBT group with that of the CBT group in the OSCE1 pretest, OSCE2 postintervention, and OSCE3 posttest (Figure 3A). There was no significant difference in OSCE1 pretest scores between the CBT group and the GBT group. Both groups obtained significantly different scores after one week (posttest1-OSCE2) and after one month (posttest2-OSCE3) ( $P < 0.001$  and  $P < 0.001$ , respectively; Table 1).

A paired t-test was used to compare the results between pretest, posttests 1, and posttest 2 both within and between the intervention and control groups. The paired t-test indicated statistically significant differences in both groups' mean pretest and posttest scores1 (Table 1). In posttest 1, one week after training, there was a significant difference between the pretest scores ( $16.27 \pm 2.52$ ) and posttest scores ( $69.23 \pm 6.14$ ) for the GBT group ( $P = 0.001$ ). Nevertheless, there was no statistically significant difference ( $P = 0.056$ ) when comparing posttest scores one month after GBT ( $69.03 \pm 6.09$ ) with posttest scores one week after ( $69.23 \pm 6.14$ ). In addition, the highest scores were obtained in the CBT group 1 week after training ( $54.83 \pm 6.61$ ); these were significantly higher than the pretest scores ( $16.40 \pm 2.27$ ) ( $P < 0.001$ ). In addition, there was a statistically significant difference between posttest 1 and posttest 2 scores in the CBT group. Students' behavioral fluency scores decreased significantly ( $P < 0.0001$ ) one month after the intervention ( $47.97 \pm 5.49$ ) compared with one week after ( $54.83 \pm 6.61$ ) (Table 2).

### 4.2. Knowledge

According to the results, the mean score of the theoretical test at baseline did not differ significantly between the study groups ( $p = 0.534$ ). Mean scores of students in GBT were significantly higher than those in CBT after training ( $p$



**Table 1:** Comparing the knowledge and behavioral fluency scores between game-based (intervention) and case-based (control) groups during Pretest, Posttest 1, and Posttest 2

Groups	Intervention	Control	P value
<b>Behavioral fluency scores</b>			
Pretest	16.27± 2.518	16.40 ± 2.268	0.8301
Posttest 1	69.23 ± 6.140	54.83 ± 6.608	<0.0001
Posttest 2	69.03 ± 6.088	47.97 ± 5.493	<0.0001
<b>Knowledge scores</b>			
Pretest	12.43 ± 3.901	11.83 ± 3.524	0.5344
Posttest	74.17 ± 6.492	53.10 ± 9.038	<0.0001

Data are presented as mean ± standard deviation.

**Table 2:** The Comparison of the behavioral fluency scores within game-based (intervention) and case-based (control) groups in pretest and Posttests (1 and 2)

Paired tests	Mean				P value
	Pretest	Posttest 1	Posttest 2	Mean of differences ± SD	
<b>Control</b>					
Posttest 1-Pretest	16.40	54.83		38.43 ± 6.971	<0.0001
Posttest 2-Pretest	16.40		47.97	31.57 ± 5.987	<0.0001
Posttest 1-Posttest 2		54.83	47.97	6.867 ± 2.193	<0.0001
<b>Intervention</b>					
Posttest 1-Pretest	16.27	69.23		52.97 ± 6.764	<0.0001
Posttest 2-Pretest	16.27		69.03	52.77 ± 6.689	<0.0001
Posttest 1-Posttest2		69.23	69.03	0.2000 ± 0.550	0.0563

< 0.001). Mean scores of both groups increased significantly after training compared to baseline ( $p < 0.001$  for GBT,  $p < 0.001$  for CBT; Table 1 & Figure 3b).

## 5. Discussion

In the current study, which aimed to examine how GBT with Precision Teaching affects the behavioral fluency and knowledge of nursing students, a significant improvement in their knowledge of disaster and crisis management was found. Furthermore, behavioral fluency of acquired clinical decision-making skills in disaster situations remained unchanged after one month of the intervention compared to one week after the intervention. Thus, the results support the hypothesis that nursing students can improve their knowledge and behavior fluency in crisis & disaster management through the game.

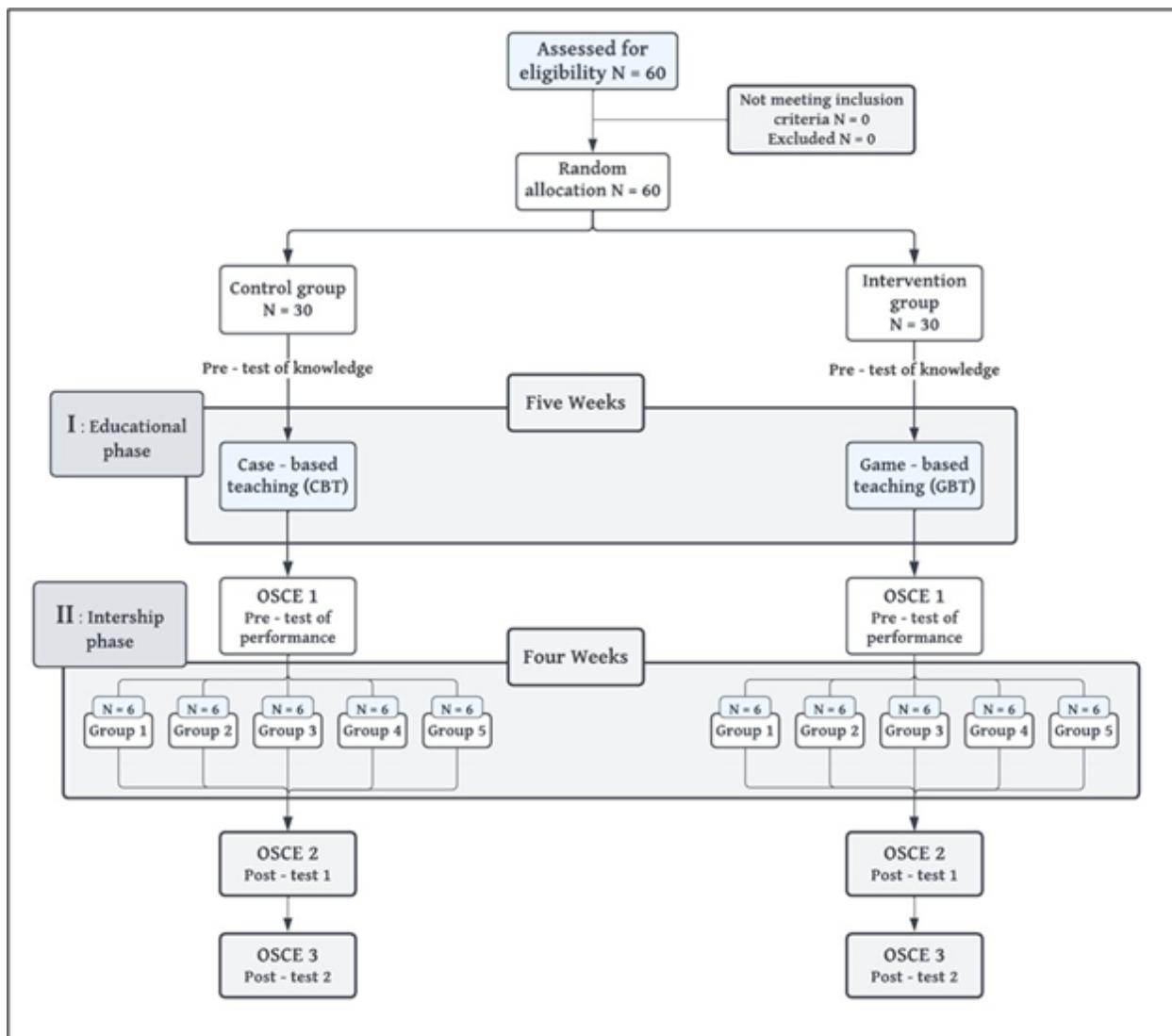
Results showed that GBT students had higher theoretical test scores than CBT students. Although both groups' theoretical test scores increased after the intervention, the increase was more pronounced for the GBT group. Thus, Throughout the instruction and theory phase, students improved their disaster knowledge. The control group's scores on self-assessed knowledge were lower than those of the intervention group, possibly due to an improvement in students' intrinsic motivation to achieve the game goal. Games can provide an enjoyable and relaxing environment for learning and practice,

in contrast to the psychological feeling of uncertainty that students experience during scenario simulation (23).

The result shows that most students in both groups lacked knowledge of crisis and disaster management before the study. Similar to the current study, a study in Jordan (2012) examined nurses' perceptions of crisis management and concluded that nurses' preparedness to deal with crisis situations was generally low (24). In addition, this study showed that nurses have lower knowledge of disaster preparedness than their clinical skills. The study by Hajjavi (2009) in Zanjan hospitals showed that 76.8% of managers and supervisors had unacceptable knowledge regarding crises and disasters (25).

In this context, according to Latifi (2019), crisis management education programs could reduce the mortality rate of those injured in a disaster (26). This is because such programs promote awareness of the programs available to manage disasters among hospital staff, increase staff's participation in planning and solving existing problems, and improve staff's competence in performing their assigned tasks.

According to the study by Sharifzadeh (2020), "Play and Learn for Surgeons" improved surgical instrument handling and knowledge of obstetrics and gynaecology residents during uterine artery ligation surgeries (27). In another study, the use of "PeriopSim™ Instrument Trainer" and "PeriopSim™ for Burr hole Surgery" in neurosurgery residents significantly improved outcomes, saved time, and reduced er-



**Figure 1:** The flow diagram illustrates the activities that occurred during this study. The study was conducted in two phases: an educational and an internship phase. In the educational phase, students were randomly assigned to the intervention and control groups, and two teaching methods were used. In the internship phase, students were reassigned to groups and received the same clinical education. Grouping was done in groups of 6; 5 standardized patients were used to implement the 5-stage Pazin model in the simulation. OSCE: Objective Structured Clinical Examination.

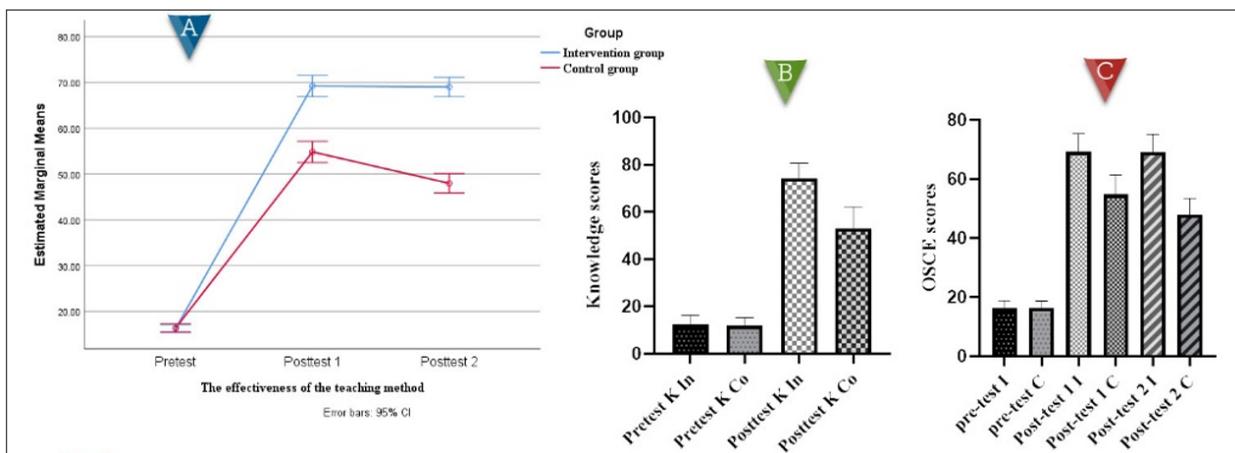
rors in identifying neurosurgical instruments during simulated burr hole surgeries (28). The Ma (2021) study examined the effects of themed games and scenario simulations on nursing students' disaster nursing competence and found that nursing students in the group taught by theme games had significantly higher disaster nursing competence scores (29). Another disaster training study found that students understood mass casualty incidents (MCIs) and teamwork better by playing an escape room game (30). Studies have shown that serious games significantly impact student learning and skills in disaster nursing. CPR training is one area where

games effectively improve students' disaster nursing skills (31). The results of the current study regarding the effects of game-based training on behavioral fluency and knowledge of nursing students in the field of crisis & disaster management are similar to those of the studies reviewed; however, the comparison should be made with caution because of differences in the populations studied, the game objectives and designs, and the methods used to assess trainee performance. Accordingly, there was no statistical difference between the intervention and control groups on the OSCE pretest be-





**Figure 2:** Design of the game environment using Articulate Storyline 3 software. The design of the training sections and the question scenarios are shown in this combined image.



**Figure 3:** (A) Graph of repeated measures for the effect of education on student performance. (B) Comparison of students' knowledge scores in GBT and CBT. (C) Comparison of Objective Structured Clinical Examination (OSCE) test scores at three-time points in the intervention and control groups. CI: Confidence interval; K: Knowledge; I: intervention group; C: Control group.

fore the internship phase. Accordingly, the game did not significantly affect students' performance in theory classes. Although both groups received the same clinical training, the better performance of students in the game group after the internship phase in OSCE posttest 1 and posttest 2 suggests that the game may help reduce negative cognitive load

during clinical training. Therefore, it is likely that training through games can reduce the effects of stress in critical situations, leading to an increase in performance stability, as demonstrated in posttests 2 and 3.



## 6. Limitations

First, a limitation of the present study was the lack of training facilities and equipment. Hospitals that had already conducted crisis management workshops were consulted to address the equipment shortage problem. Second, since disasters are unpredictable, hospitals and regions have specific needs based on anticipated and unanticipated disasters, making generalizations difficult.

Therefore, the results of this study should not be generalized to other hospitals or regions because they are based on data from a single geographic area. In order to evaluate GBT incorporating precision teaching, more robust experimental designs are needed. However, implementing such designs in a clinical environment may be challenging.

## 7. Conclusion

Nursing trainees gained behavioral fluency in disaster and crisis management through GBT with frequency building and precision teaching. Observations indicate that the intervention yielded a level of performance learning that was retained was stable and appeared to transfer to the simulated real-world setting. A review of the results of the present study indicates that nursing students' knowledge and behavioral fluency regarding crisis management were more effectively improved by using the disaster and crisis game than by using a case-based method. Disaster and crisis games can help nursing students develop skills in this area.

However, further long-term studies with larger sample sizes are needed to confirm this finding. In medical education, fluency training and precision teaching should be further explored.

## 8. Declarations

### 8.1. Acknowledgments

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### 8.2. Authors' contributions

T.M.H., and M.M.H. wrote the manuscript draft. T.M.H. & M.M.H. & K.Q. designed the study. M.M.H. did the data gathering. N.B conducted the analyses. All authors reviewed and approved the manuscript.

### 8.3. Conflict of Interest

The authors have no conflicts of interest.

### 8.4. Fundings and supports

This research was supported by the Vice-Chancellor of the Smart University of Medical Sciences (No. 321).

### 8.5. Data Availability

Upon a reasonable request, the corresponding author can provide the data set that was analyzed during this study.

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