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Action Maze and Role Playing in comparison: A Randomized Field Trial on simulation-based teaching methodologies in critical care

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Keywords: Nursing students; teaching methodology simulation; gamification; action maze; role playing; critical care education.

Parole Chiave: Studenti di infermieristica; metodologie di insegnamento simulative; gamification; action maze; role playing; formazione in area critica.

Abstract

Background. *The training of healthcare professionals requires continuous innovation in teaching methodologies to foster the development of professional skills. The use of simulation in critical care is a proven effective technique, allowing students to acquire and consolidate the necessary knowledge to plan and implement nursing care in clinical practice. Interactive teaching strategies aim to increase student engagement and motivation in order to improve the learning process, decision-making, and critical thinking. New technologies that leverage gamification provide further advancements in interactive learning and represent a valuable and promising tool for training in various healthcare contexts.*

This study aims to analyze and compare two simulated teaching methodologies, Role Playing and Action Maze, and assess their effectiveness in terms of the acquisition of specific knowledge in the critical care field and the level of satisfaction among nursing students.

Materials and Methods. *A Randomized Field Trial was conducted. A total of 130 third-year nursing students from the Sapienza University of Rome were enrolled in the study, with 60 students from course D and 70 students from course X. An initial lecture was given on nursing care for critical patients. At the end of the lecture, a custom-designed questionnaire was administered to evaluate the knowledge acquired. The students were then randomly allocated into two groups: one group was assigned to Role Playing, and the other to Action Maze. At the end of the two simulated teaching activities, the questionnaire was administered again to assess changing in knowledge. Additionally, two validated scales, the Educational Practice Questionnaire Student Version and the Simulation Design Scale Student Version, were administered to assess student satisfaction and perception regarding the simulation techniques performed.*

Results. *The Wilcoxon signed-rank test with Z=-2.1 and p=0.03, performed on the correct post-intervention responses, was significant with a p-value of <0.05 for the Action Maze group compared to the Role Playing group. The Simulation Design Scale Student Version scale showed a p-value of <0.05 for both the "teaching methodology" and "importance of elements" sections. The Educational Practice Questionnaire Student Version scale showed a p-value of 0.076 for the evaluation of the "importance of elements" section.*

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Conclusions. *The results of the study indicated that the Action Maze simulation teaching methodology was more effective, both in terms of knowledge acquisition and student satisfaction, compared to the Role Playing methodology. Further comparative studies are recommended to evaluate the effectiveness of the Action Maze compared to other simulated teaching methods.*

Introduction

The acquisition of nursing skills in caring for critical patients requires carefully structured training interventions, that must be based on teaching methodologies with proven effectiveness (1). Given the complexity and diversity of the educational pathway in critical care, traditional teaching techniques alone may be insufficient for learning the skills required to manage emergency clinical situations. Over the years, various teaching methods have been implemented that involve group cooperation and active student participation (1). This enables students to develop and demonstrate their own skills, abilities, and personal experiences to build their competencies (2). The scientific literature agrees in identifying teaching methodologies focused on developing critical thinking as effective tools in facilitating problem-solving and decision-making abilities independently in highly complex care situations (2). Several studies suggest that training strategies need to be designed based on interactive learning styles integrated with traditional lectures (2,3). Among the most effective are methods that use simulation strategies, where scenarios are as realistic as possible. One of the most commonly used simulation methodologies is Role Playing (RP), a simulation technique that recreates situations and issues similar to clinical practice, involving students in role-playing scenarios (4). Despite its numerous advantages, such as developing critical thinking and increasing student self-confidence, RP also has several limitations that reduces its effectiveness in educational activities (5). A major drawback is the limited evidence in the literature regarding the potential learning benefits this methodology offers students. In addition, existing studies often feature small sample sizes (5). The use of innovative tools that combine the benefits of technology with those of simulation activities can serve as valid teaching strategies (6). One tool that shows the potential to create this synergy is the Action Maze (AM), a specific learning methodology achieved through interactive simulations of clinical cases using technological devices. Students must choose the most appropriate interventions from various proposed options, and with each decision, the participant is directed to a new clinical scenario (7). As a result, the students build their own decision-making path based on the different choices made (7). The methodology utilises gamification, which involves the use of game elements to increase student engagement, motivation and interactivity in the learning process (8). It also allows students to test, stimulate, and verify their knowledge (9). Critical thinking development and decision-making processes are essential elements in clinical nursing practice, particularly in critical care settings (10,11). Although several studies in Italy demonstrate the contribution of technology to simulation-based teaching in nursing education, particularly in intensive care (12), few of them consider the impact of gamification on nursing students' learning. In this context, AM could assist nursing students in learning priority tasks and later applying them in real clinical situations. This study aims to compare the two simulation methodologies, Role Playing and Action Maze, to evaluate their effectiveness in critical care in terms of learning and satisfaction among nursing students.

Materials and methods

1. Design

A clinical case related to nursing care for critical patients was designed. Each nursing intervention was outlined in an algorithm with various decision-making options (Figure 1). The algorithm was then integrated into a program that creates interactive mazes, where students are given the opportunity to choose sequential actions based on the case under examination (Figure 2). The interactive game presents multiple options, each leading the student to a decision point. ultimately resulting in either the resolution or failure of the process. If students make decisions that are not conducive to solving the maze, the simulation activity is considered incomplete and can be restarted either from the beginning or from the

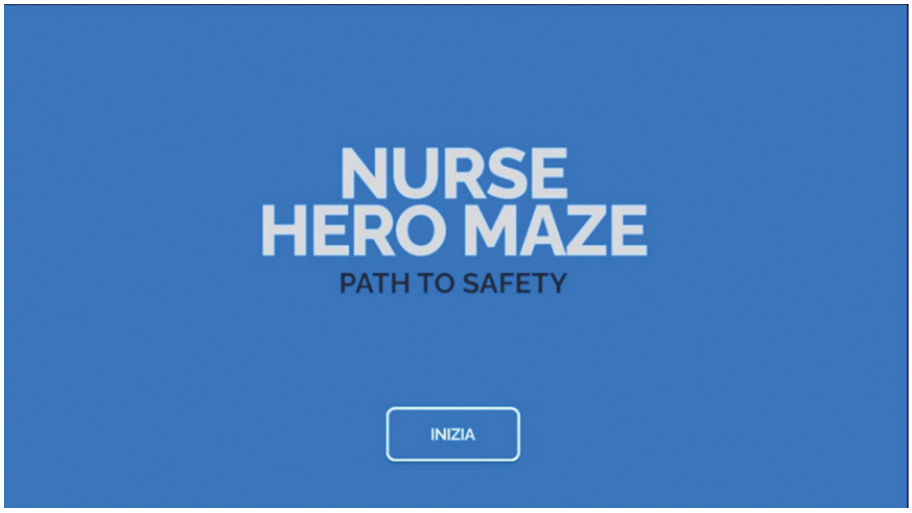

Figure 1 - Main screen of the developed AM program.

decision point where the incorrect choice was made. The game algorithm was developed by the researchers themselves, using software that facilitated a branching narrative sequence. The game's questions, presented to students, lead to three possible branches based on their answers, creating a variable outcome to the clinical question.

2. Study Design and Sampling

A randomized field trial (RFT) was conducted. A convenience sampling method was chosen, as participants were recruited from a mandatory Elective Teaching Activity (ADE) included in the curriculum.

Sample size calculations were made using the following parameters with Epicalc 2000:

Mean 1st group = 7.50
Mean 2nd group = 8.00
SD = 1.00
Significance = 0.05
Power = 80%

Based on this calculation, we estimated enrolling a sample size of 62 students in each group, with a total sample of 124.

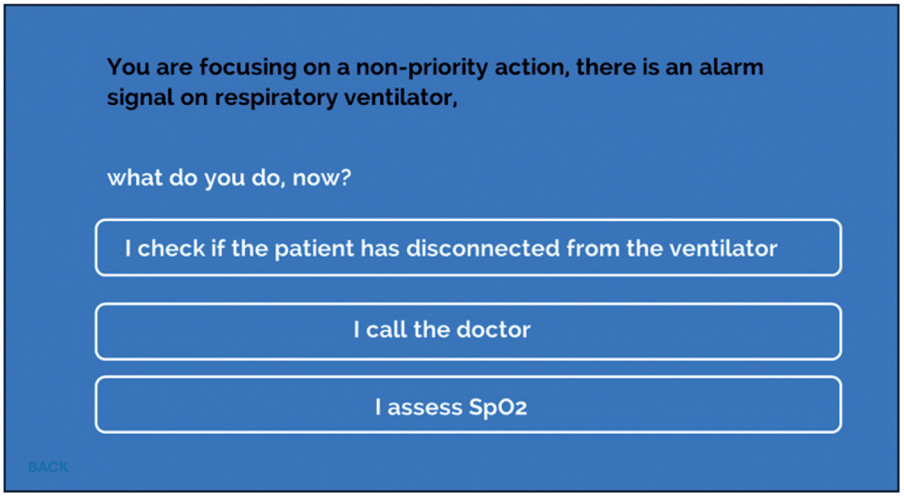

Figure 2 - Example of the AM path selection algorithm.

In total, 130 nursing students were included, belonging to the D Teaching Channel (60 students) and X Teaching Channel (70 students) of the third year of the Nursing Degree Program at the Sapienza University of Rome.

Eligibility criteria included not having previously participated in the ADE in question and being in the third year of the Nursing Degree Program. Exclusion criteria were belonging to teaching channels other than those included and being enrolled in the first or second year of the Nursing Degree Program. The criteria were defined based on the educational objectives outlined in the third-year curriculum of the Nursing Degree Program.

The RFT took place over two days: on April 26, 2024, for Channel X and on April 30, 2024, for Channel D. Each intervention lasted approximately 6 hours.

The first intervention consisted of a lecture on nursing care for critical patients, with particular attention to the assessment of patients with compromised hemodynamic, respiratory, and neurological function, emergency procedures, and interventions for the return of spontaneous circulation after cardiac arrest (ROSC).

At the end of the lecture, a tailored questionnaire (Appendix 1) was administered to assess the changing in knowledge. The questionnaire consisted of 19 questions divided into the following sections: 4 related to sociodemographic data (ID code, gender, age, and teaching channel) and 15 multiple-choice questions on the topics covered in the lecture.

The instrument was developed following a pilot study (13), conducted on 30 students with similar characteristics to the sample (belonging to different teaching channels), which involved administering the questionnaire at T0 and after 48 hours.

After completing the post-lecture questionnaire, students were divided into two groups: one assigned to Role Playing (RP) and the other to Action Maze (AM). Simple randomisation was performed, and each participant was assigned a numerical ID code generated through Excel software.

The RP group (a total of 64 participants) was further divided into 2 subgroups, each supervised by a different educator. The AM group (a total of 66 participants) was further divided into 6 subgroups (minimum of 5, maximum of 6 people). Each subgroup was provided with a laptop containing a clinical case simulation based on the AM methodology.

Both simulations lasted approximately 60 minutes.

At the end of the two simulations, participants were administered the questionnaire again (Appendix 1). In addition, two validated scales were administered: the Educational Practice Questionnaire Student Version (EPSS) (14) and the Simulation Design Scale Student Version (SDS) (15), which measure students' satisfaction with the simulated teaching methodologies.

Specifically, the EPSS asks students to evaluate the teaching methodology in relation to 4 items: active learning, collaboration, different learning styles, and other expectations, for a total of 16 questions. The SDS evaluates 5 items: objectives and information, support, problem-solving, feedback, and appropriateness, for a total of 20 questions. Students rated each item on a scale from 1 (strongly disagree/unimportant) to 5 (strongly agree/very important).

3. Ethical Considerations

The study was conducted with prior approval from the Ethics Committee of the University of Rome "La Sapienza" (protocol number 0209/2024). Students were informed about the study's objectives, interventions, and data collection and dissemination methods. Written informed consent was obtained from all participants. The study adhered to the principles of the 2013 Declaration of Helsinki and current regulations. Data confidentiality was ensured as per GDPR No. 2016/679.

4. Statistical Analysis

Data were analysed using the Statistical Package for Social Science (SPSS) (16) software, version 25.5. A p-value < 0.05 was considered significant. Inferential statistical analyses were conducted, including mean (M), standard deviation (SD), ANOVA (Analysis of Variance), and frequency measures expressed as percentages. Fisher's test was used to verify the homogeneity of variances between populations. Differences between the two groups for categorical variables were tested using the Chi-square test. The Wilcoxon signed-rank test was performed to assess differences for paired data for quantitative variables.

Results

The recruitment, allocation, and sample analysis are summarised in the CONSORT 2010 Flow Diagram (Figure 3).

All students who participated in the ADE from Channels D and X were enrolled, totalling 130

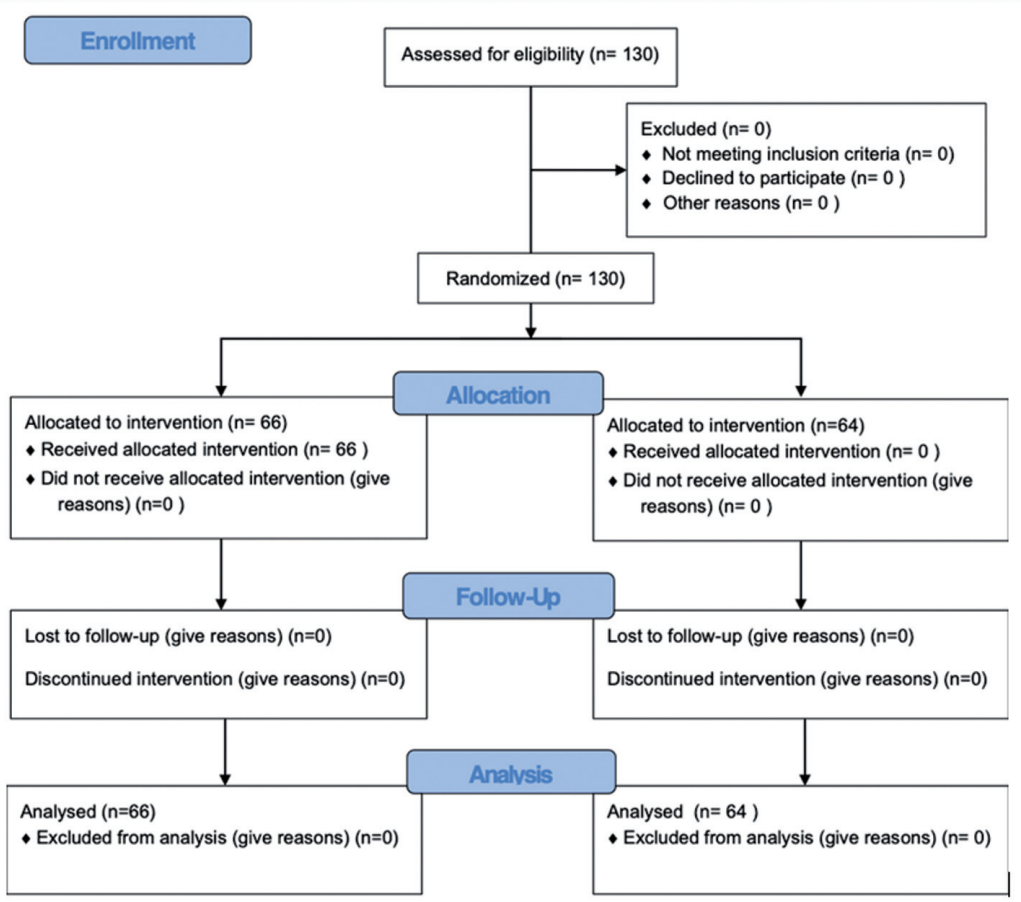

Figure 3 - CONSORT Flow Diagram 2010 Participants.

participants. In Channel D, the group that performed the Action Maze (AM) (case group) consisted of 66 students (48.5%), while the group that performed the Role Playing (RP) (control group) included 64 participants (43.8%). In Channel X, the case group consisted of 66 students (51.5%) and the control group included 64 students (56.3%). The sample analysis showed that the sampling was homogeneous in terms of gender and age (Table 1). The mean (M) for the total of both groups (n = 130) was 27.05, with a standard deviation (SD) of 6.292.

The average score of correct answers for the entire sample (n = 130) on the questionnaire administered after the lecture was M = 12.37 with a standard deviation (SD) of 1.690. After the simulation interventions (AM and RP). the average score of

Table 1 - Sample Analysis Results.

		Role Playing	Action Maze	Total	P
Age	Average (DS)	26.34 (5.62)	27.74 (6.85)	27.05 (6.29)	0.206
Sex	F	45 (70.3%)	46 (69.7%)	91 (70%)	0.939
	M	19 (29.7%)	20 (30.3%)	39 (30%)	
Didactic channel	D	28 (43.8)	32(48.5%)	60 (46.2)	0.588
	X	36 (56.3%)	34 (51.5%)	70 (53.8%)	

Table 2 - Results of Correct Responses on the Evaluation Questionnaire Pre- and Post-Simulation Interventions.

		Role Playing	Action Maze	p
Accurate answers PRE	Average (DS)	12.42 (1.42)	12.32 (1.92)	0.728
Accurate answers POST	Average (DS)	12.84 (1.37)	13.77 (1.08)	< 0.001

correct answers was M = 13.32 with SD = 1.312. Specifically, the RP group had the following results: M = 12.84. n = 64. SD = 1.371. The AM group obtained: M = 13.77. n = 66. SD = 1.078. with a statistically significant p-value of < 0.001 (Table 2).

The Wilcoxon signed-rank test was conducted for the correct answers post-intervention, with a significance level of $p < 0.05$. The AM group achieved a higher number of correct answers compared to the RP group (Figure 4).

The responses obtained from the administration of the SDS scale regarding the specific section related to the evaluation of the "teaching methodology" totalled 128, with the exclusion of 2 participants due to incomplete questionnaires. The AM group obtained the following results: M = 4.8447. n = 66. SD = 0.30510. The RP group: M = 4.6677. n = 62. SD = 6.4783. The p-value was 0.048 (Table 3).

The responses obtained from the SDS scale to assess the "importance of the elements" totalled 130. The results for the AM group were: M = 4.8826. n = 66. SD = 0.30300. The results for the RP group were: M = 4.6336. n = 64. SD = 0.79612. The p-value was 0.019 (Table 4).

The EPSS scale, regarding the "teaching methodology" section, produced the following results for the AM group: M = 4.7869. n = 66. SD = 0.36983. In the RP group, the results were: M = 4.7391. n = 63. SD = 0.42427. The p-value was 0.495 (Table 5).

The results of the EPSS scale for evaluating the "importance of the elements" section were as follows for the AM group: M = 4.8381. n = 66. SD = 0.36542.

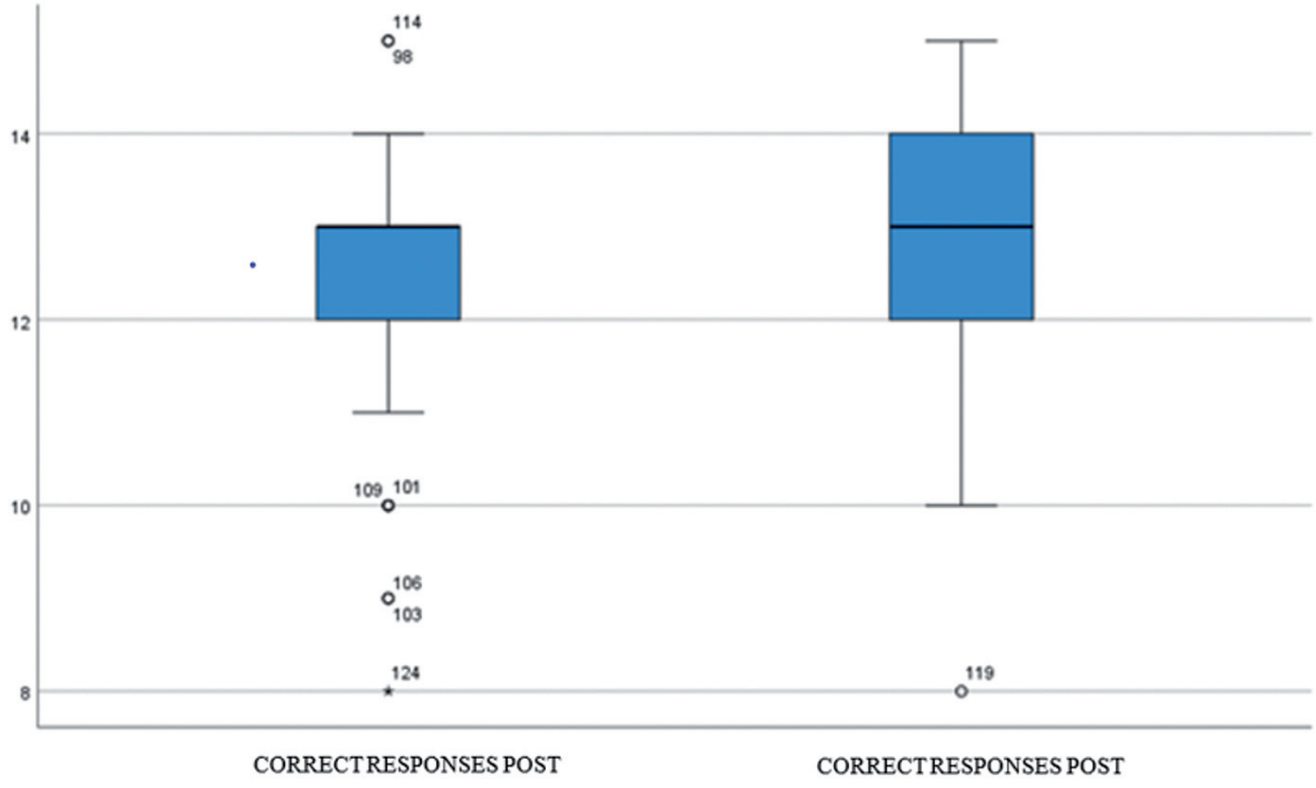

Figure 4 - Box Plot of Correct Responses Pre- and Post-Simulation Interventions.

Table 3 - Results of the SDS Scale for the "Teaching Methodology" Section.

SDS evaluation of didactic methods		Objectives and Information	Support	Problem Solving	Feedback/Guided Reflection	Appropriateness
Role Playing	Average (DS)	4.73 (0.71)	4.73 (0.59)	4.62 (0.68)	4.65 (0.74)	4.58 (0.84)
Action Maze	Average (DS)	4.81 (0.41)	4.83 (0.32)	4.88 (0.27)	4.86 (0.40)	4.84 (0.51)
Total	Average (DS)	4.77 (0.57)	4.78 (0.48)	4.75 (0.55)	4.76 (0.60)	4.72 (0.70)
P		0.389	0.257	0.006	0.048	0.040

Table 4 - Results of the SDS Scale for the "Importance of the Elements" Section.

SDS evaluation of the importance of elements		Objectives and Information	Support	Problem Solving	Feedback/Guided Reflection	Appropriateness
Role Playing	Average (DS)	4.71 (0.80)	4.66 (0.78)	4.65 (0.80)	4.55 (0.96)	4.52 (0.99)
Action Maze	Average (DS)	4.84 (0.42)	4.88 (0.35)	4.90 (0.30)	4.91 (0.29)	4.91 (0.34)
Total	Average (DS)	4.77 (0.64)	4.77 (0.61)	4.76 (0.61)	4.72 (0.72)	4.72 (0.76)
p		0.260	0.043	0.018	0.004	0.003

Table 5 - EPSS Results for the "Teaching Methodology."

EPSS evaluation of didactic methods		Active Learning	Collaboration	Different ways of learning	Other expectations
Role Playing	Average (DS)	4.73 (0.44)	4.76 (0.48)	4.69 (0.63)	4.80 (0.44)
Action Maze	Average (DS)	4.75 (0.44)	4.87 (0.31)	4.84 (0.37)	4.83 (0.38)
Total	Average (DS)	4.74 (0.44)	4.82 (0.40)	4.77 (0.52)	4.82 (0.40)
p		0.841	0.126	0.117	0.658

Table 6 - EPSS Results for the "Importance of the Elements" Section.

EPSS evaluation of the importance of elements		Active Learning	Collaboration	Different ways of learning	Other expectations
Role Playing	Average (DS)	4.65 (0.64)	4.69 (0.65)	4.70 (0.68)	4.77 (0.58)
Action Maze	Average (DS)	4.81 (0.41)	4.92 (0.25)	4.89 (0.37)	4.83 (0.44)
Total	Average (DS)	4.73 (0.54)	4.81 (0.50)	4.79 (0.55)	4.80 (0.51)
p		0.096	0.009	0.058	0.453

For the RP group. the results were: M = 4.6797. n = 64. SD = 0.61515. The p-value was 0.076 (Table 6).

Discussion

The study conducted demonstrated that the Action Maze (AM) simulation-based teaching methodology is more advantageous compared to the Role Playing (RP) methodology. The groups involved were homogeneous in terms of size, age, and gender, lending validity to the correlation of the results. Nursing students who participated in the AM achieved significantly better results in terms of correct answers on the evaluation questionnaire compared to students who used RP. The Wilcoxon test results showed a statistically significant difference in mean scores between the two groups ($p < 0.05$). Nonetheless, there was an overall improvement in knowledge after the simulation interventions among the participants. This aligns with the existing literature on the impact of simulation methods on student knowledge acquisition, highlighting statistically significant differences favouring interactive methodologies over traditional lectures (17). The improved results achieved through AM confirm the literature on the effectiveness of gamification techniques, both in terms of knowledge expansion and participant satisfaction (18-20).

Student satisfaction, measured through the validated questionnaires Simulation Design Scale Student Version (SDS) and Educational Practices Questionnaire Student Version (EPSS), was overall higher for AM than for RP. The SDS results suggest that students consider AM a simulation that better facilitates problem-solving and the analysis of one's behaviour and actions compared to RP. Analysis of the EPSS seems to indicate that students perceive AM as a methodology that stimulates collaboration and group work more than RP.

These differences can be explained by the advantages provided by the technology used in AM, which allows for interactivity and student engagement. The possibility of conducting the simulation via mobile devices facilitates student practice, both individually and in groups. Additionally, AM allows for an unlimited number of attempts, helping students reinforce their knowledge. The use of technology also overcomes the limitations present in RP, which are tied to the skills and abilities of the facilitator running the simulation (4); such subjectivity is not present in AM.

However, the study has limitations related to the limited availability of electronic devices used during AM. This led to the creation of a numerically smaller subgroup for AM compared to the RP subgroup. For the AM method to be maximally efficient, each student must have independent access to a personal electronic device. Another potential limitation is the lack of blinding and absence of follow-up, which could have provided information on the effectiveness of AM in maintaining the knowledge acquired. Although follow-up has been evaluated in studies investigating the ability of simulation methods to maintain acquired competencies (21), there is no evidence supporting the impact of gamification or algorithm-based methodologies on this aspect.

It would be desirable to conduct the RFT in other universities, educational channels, or different disciplines and to extend it to a larger sample. To further assess the effectiveness of AM, it is suggested to develop and administer clinical cases related to areas outside of Critical Care and evaluate their impact in terms of knowledge acquisition and student satisfaction. It could also be beneficial to repeat the study using different scales that assess student satisfaction to capture aspects that may not have been detected by the tools used (22). Additionally, it would be useful to compare AM with other simulation-based teaching methodologies. Given the scarcity of Italian studies comparing the didactic methodologies of AM and Role Playing, the obtained results should be interpreted cautiously. The use of AM is recommended for nursing student education and nurse training.

Conclusions

Considering the significant differences between the two research groups, it can be concluded that the AM simulation method produced better results than RP in terms of knowledge acquisition in the given setting and individual student satisfaction. The AM methodology, offering numerous advantages, may have a more significant impact on nursing student education compared to other simulation methods.

Riassunto

Action Maze e Role Playing a confronto: A Randomized Field Trial sulle metodologie didattiche basate sulla simulazione in area critica

Introduzione. La formazione dei professionisti sanitari richiede una continua innovazione delle metodologie didattiche per favorire

lo sviluppo delle capacità professionali. L'utilizzo della simulazione in area critica è una tecnica di comprovata efficacia, che permette allo studente di acquisire e consolidare le conoscenze necessarie per pianificare ed attuare l'assistenza infermieristica nella pratica clinica. Le strategie didattiche interattive hanno lo scopo di aumentare il coinvolgimento e la motivazione degli studenti al fine di migliorare il processo di apprendimento, di *decision making* e il pensiero critico. Le nuove tecnologie che sfruttano la *gamification* forniscono ulteriori sviluppi nell'ambito dell'apprendimento interattivo e rappresentano un valido e promettente strumento della formazione in molteplici contesti sanitari.

Lo studio si pone l'obiettivo di analizzare due metodologie didattiche simulative a confronto, *Role Playing e Action Maze*, e valutarne l'efficacia in termini acquisizione di conoscenze specifiche nell'ambito dell'area critica e del grado di soddisfazione degli studenti di infermieristica.

Materiali e metodi. È stato condotto un *Randomized Field Trial*. Sono stati arruolati per la conduzione dello studio in totale 130 studenti di Infermieristica del terzo anno del corso di Laurea dell'Università degli Studi di Roma "La Sapienza", appartenenti al canale D (60 studenti) e al canale X (70 studenti). È stata effettuata una prima lezione frontale in merito all'assistenza infermieristica al paziente critico. Al termine della lezione frontale è stato somministrato un questionario costruito *ad hoc* per valutare le conoscenze acquisite. Gli studenti, previa randomizzazione, sono stati successivamente suddivisi in due gruppi: un gruppo è stato assegnato al *Role Playing* ed un gruppo all'*Action Maze*. Al termine delle due attività didattiche simulative è stato somministrato nuovamente il questionario per la valutazione dell'acquisizione delle conoscenze. Sono state, inoltre, somministrate due scale validate, l'*Educational Practice Questionnaire Sudent Version* e la *Simulation Design Scale Student Version*, per valutare la soddisfazione e percezione degli studenti in merito alle tecniche simulative eseguite.

Risultati. Il test dei Ranghi con segno di Wilcoxon, eseguito per le risposte esatte post- intervento, è stato significativo con $p < 0.05$ per il gruppo Action Maze rispetto al gruppo del Role Playing. La scala *SDS* ha avuto per entrambe le sezioni "metodologia didattica" e "importanza degli elementi" un *p value* < a 0.05. La scala *EPSS* ha avuto per la valutazione della sezione "importanza degli elementi" ha avuto un *p value* = 0.076.

Conclusioni. Dai risultati ottenuti dallo studio condotto è emerso che la metodologia didattica simulativa *Action Maze* risulta essere più vantaggiosa, sia in termini di acquisizione delle conoscenze che di soddisfazione degli studenti, rispetto alla metodologia del *Role Playing*. Sarebbe auspicabile condurre ulteriori studi di confronto, al fine di valutare l'efficacia dell'*Action Maze* rispetto ad altre metodiche didattiche simulative.

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