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Effectiveness of medical simulation in the education of nursing students

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Abstract

Introduction: Medical simulation is a complex teaching method commonly used in academic education. It serves as a key tool in the education of nursing students, allowing them to acquire practical skills in a safe, controlled environment.

Aim: The aim of the study was to analyze the effectiveness of the education of nursing students using medical simulation as a teaching method.

Material and methods: The study was conducted from October 2023 to January 2024 at the Zamość Academy in Zamość and the Lublin Academy WSEI in Lublin. The study included nursing students who participated in classes at the Medical Simulation Center, having previously been qualified for the study. The diagnostic survey method was used for material collection. The research tools included the Educational Practices Questionnaire (EPQ) and the Simulation Design Scale (SDS). The study received a positive opinion from the Bioethics Committee of the Zamość Academy, and the participants were informed about the voluntary nature of participation and the principles of anonymity.

Results: The students gave the highest rating to educational techniques related to cooperation (Me = 5.0). Statistical analysis showed a weak negative correlation between age and the evaluation of active learning (R = –0.137; p = 0.016), expectations (R = –0.181; p = 0.001), and the overall evaluation of educational techniques (R = –0.141; p = 0.014). Students with children rated the expectations domain significantly lower (p = 0.027). A weak negative correlation was found between age and the evaluation of objectives and information (R = –0.180; p = 0.002), support (R = –0.154; p = 0.007), and the overall evaluation of simulation assumptions (R = –0.145; p = 0.011). The realism of scenario elements was rated the highest (Me = 5.0).

Conclusions: The study showed that the students rated educational techniques related to collaboration the highest, recognizing this area as crucial in the educational process. With increasing age, the evaluation of scenario elements decreases, including objectives and information, support, and overall assumptions of medical simulation. Students with children rated the expectations domain of educational techniques significantly lower. Students highly rated the realism of the simulation, considering it an essential element in education that will have a significant impact on their future professional practice.

Key words: medical simulation; simulation effectiveness; SDS scale; EPQ, nursing student

Introduction

Medical simulation is one of the fundamental teaching tools in the education of nursing students. It serves as a valuable resource in the learning process, allowing students to acquire practical skills in a safe environment. Safety and a controlled learning environment can be crucial factors influencing the effectiveness of medical simulation. This approach enables students to practice various procedures and techniques without exposing patients to risk. This form of learning allows for stress-free mistake-making and learning from errors, which is essential for the professional development of future nurses. Performing various tasks within the framework of simulation scenarios helps students develop both standard nursing procedures and complex clinical situations, including crisis scenarios. As a result, future nursing professionals are better prepared for a wide range of situations they may encounter in their careers. Students have the opportunity to repeatedly practice specific procedures, increasing their confidence and precision in performing dedicated tasks. Additionally, both individuals and teams can train their responses to sudden and difficult situations in controlled conditions, significantly improving their readiness for real-life circumstances. In the chosen research area, "Effectiveness of Medical Simulation in the Education of Nursing Students," there is a niche in the scope of this research in Poland. Therefore, there is a need to analyze the effectiveness of medical simulation as a teaching method in the education of nursing students.

Aim

The aim of the study was to analyze the effectiveness of nursing education using medical simulation as a teaching method.

Material and methods

The study was conducted between October 2023 and January 2024 at Zamość Academy in Zamość and Lublin Academy WSEI in Lublin. A total of 306 nursing students from undergraduate and graduate programs (both full-time and part-time) across all academic years participated in the study. All the students attended classes at the Medical Simulation Center (CSM), ensuring an appropriate sample representation for evaluating educational practices and medical simulation assumptions. Participation in the study was voluntary, and the students were informed about the

nature of the study and the principles of anonymity. The research project received a positive opinion from the Bioethics Committee of Zamość Academy, designated with the approval number KBAZ1/2024. The study was conducted using the diagnostic survey method, using research tools such as the Educational Practices Questionnaire (EPQ) and the Simulation Design Scale (SDS).

The students evaluated the elements of the EPQ questionnaire using two rating scales: one assessing their agreement with specific statements about educational techniques and the other evaluating the importance of these statements in the context of their own educational experiences. When rating educational techniques, a five-point scale was used, where 1 meant "Strongly disagree," and each subsequent number represented an increasing level of agreement with a given statement. If a given statement did not apply to the simulation exercise being performed, the participant selected the N/A (Not Applicable) option, indicating that the statement was irrelevant to the specific exercise. Additionally, the students assessed the importance of each statement in the context of the applied educational technique using a five-point importance scale, where 1 meant "Not important" and 5 meant "Very important." A five-point rating system was used when rating the best elements of the scenario on the SDS scale. As the numerical value increased, the participants expressed a stronger agreement with a given statement. If a statement did not apply to the simulation scenario, the N/A (Not Applicable) option was selected. Additionally, the students rated the importance of specific aspects of the scenario for their educational experience using the following scale: 1–Not important, 2–Slightly important, 3–Neutral, 4–Important, 5–Very important. The study was designed based on the NLN Jeffries simulation framework, developed for the advancement and implementation of simulation in nursing education [14]. This simulation framework addresses the following issues of simulation: design (objectives, fidelity, problem-solving, student support, and debriefing), educational practices (active learning, feedback, student-instructor interaction, collaboration, high expectations, diverse learning methods, and time allocated for task completion), outcomes (learning, knowledge acquisition, skill performance, learner satisfaction, critical thinking, and confidence).

The collected data underwent an quantitative analysis (frequencies, percentages, and descriptive statistics) and a qualitative analysis. Statistical calculations were performed using Statistica 13.3 (StatSoft), applying the following statistical tests: Spearman's correlation coefficient, the Mann-Whitney U test, the Kruskal-Wallis test. For variables with a non-normal distribution, the median (Me) and quartiles (Q1–Q3) were used as measures of central tendency and dispersion. For normally distributed variables, the results were presented as the arithmetic mean

(M) and standard deviation (SD). Spearman's correlation coefficient was used to analyze the relationship between age and the evaluation of educational practices. The Mann-Whitney U test was applied to compare the results of standardized EPQ and SDS questionnaires based on education level and parental status, while the Kruskal-Wallis test was used for the marital status variable. A statistical significance level of $\alpha = 0.05$ was adopted for the analysis.

Results

The study included 306 nursing students aged 20 to 50 including 64.71% with secondary education and 35.29% reported having a higher education. The majority of the students lived in rural areas (47.05%) and were either single (51.96%) or married (41.18%). The percentage of respondents with children (48.37%) was similar to the percentage of those without children (51.63%). The sociodemographic characteristics of the students are presented in Table 1.

Table 1. Characteristics of the students

Variable	M ± SD	Me	Min–Max
Age	30.57 ± 8.12	30.0	20–50
		N	%
Education	Secondary	198	64.71
	Higher	108	35.29
Place of residence	Rural area	144	47.06
	Town	66	21.57
	City	96	31.37
Marital status	Single	159	51.96
	Married	126	41.18
	Divorced	21	6.86
Do you have children?	Yes	148	48.37
	No	158	51.63

The students evaluated the elements of the EPQ questionnaire using two rating scales: one for evaluating agreement with statements regarding educational techniques and the other for evaluating their importance in the context of educational experiences. The agreement scale ranged from 1 (strongly disagree) to 5 (strongly agree). The importance scale ranged from 1 (not important) to 5 (very important). If a statement did not apply to a given exercise, the N/A (Not Applicable) option was selected. The highest-rated educational techniques were those related to collaboration (Me = 5.0), followed by diverse learning methods (Me = 4.0) and

expectations (Me = 4.0). Collaboration was also rated as the most important aspect for the students (Me = 4.8), while the remaining factors were at a similar level. Thus, we can conclude that both the evaluation of educational techniques and their perceived importance were at a high level in the study group (Figure 1).

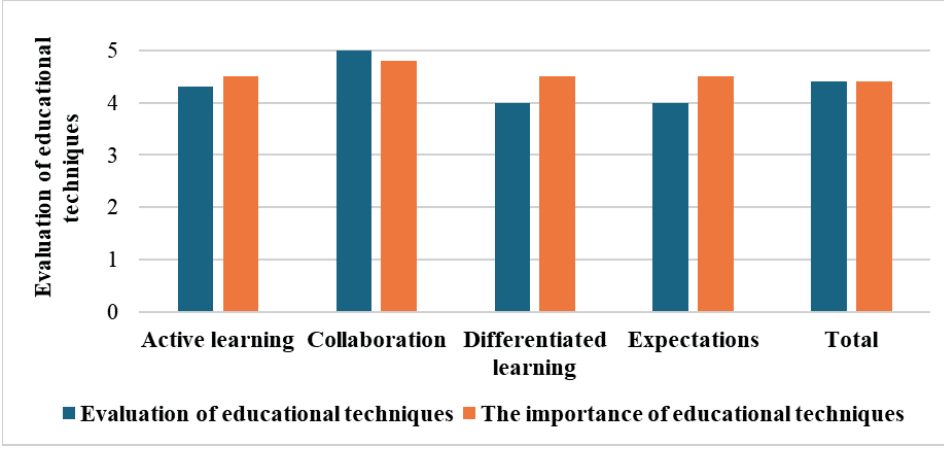

Figure 1. Evaluation of Educational Practices According to the EPQ Questionnaire; the results are presented as median and interquartile range

Statistical analysis revealed a weak negative correlation between age and the evaluation of active learning (R = –0.137; p = 0.016), expectations (R = –0.181; p = 0.001), and the overall evaluation of educational techniques (R = –0.141; p = 0.014). This indicates that as age increases, the perceived importance of these educational areas decreases. However, no significant relationship was found between age and the importance of educational techniques (Table 2).

Table 2. Evaluation of Educational Practices according to the EPQ Questionnaire among students by age

Scale	Correlation with age					
	Evaluation of educational techniques			Importance of educational techniques		
	R	t	p	R	t	p
Active learning	–0.137	–2.420	0.016	–0.001	–0.019	0.985
Collaboration	–0.100	–1.759	0.080	0.035	0.609	0.543
Differentiated learning	–0.036	–0.627	0.531	0.076	1.324	0.187
Expectations	–0.181	–3.205	0.001	–0.005	–0.081	0.935
Total	–0.141	–2.475	0.014	0.021	0.362	0.718

Legend: R–correlation coefficient between the evaluation of the scenario element and the age of the study participants

Students with children rated the expectations area of educational techniques significantly lower (p = 0.027). In other cases, the evaluation of educational techniques did not differ significantly based on parental status. Additionally, no significant differences were found in the importance of educational techniques (Table 3).

Table 3. Evaluation of Educational Practices according to the EPQ Questionnaire among the study students based on parental status

Scale	Evaluation of educational techniques				Importance of educational techniques			
	Respondent has children	Respondent does not have children	Mann-Whitney U test		Respondent has children	Renspondent does not have children	Mann-Whitney U test	
			Z	p			Z	p
Active learning	4.2 (3.8–4.6)	4.3 (4.0–4.7)	–1.525	0.127	4.5 (4.1–4.9)	4.5 (4.0–4.8)	0.209	0.834
Collaboration	5.0 (4.0–5.0)	5.0 (4.5–5.0)	–1.442	0.149	4.8 (4.0–5.0)	4.8 (4.0–5.0)	0.220	0.826
Differentiated learning	4.0 (4.0–5.0)	4.3 (4.0–5.0)	–0.354	0.724	4.5 (4.0–5.0)	4.5 (4.0–5.0)	0.507	0.612
Expectations	4,0 (3.0–5.0)	4.5 (4.0–5.0)	–2.215	0.027	5.0 (4.0–5.0)	4.5 (4.0–5.0)	–0.436	0.663
Total	4.3 (3.8–4.6)	4.4 (4.0–4.7)	–1.575	0.115	4.4 (4.0–4.9)	4,4 (4,0–4.9)	0.146	0.884

Legend: The median (Q1–Q3) is provided for each group.

Table 4. Evaluation of simulation assumptions according to the SDS Questionnaire among students by age

Scale	Correlation with age					
	Evaluation of scenario elements			Importance of scenario elements		
	R	t	p	R	t	p
Objectives and Information	–0.180	–3.184	0.002	–0.014	–0.244	0.808
Support	–0.154	–2.712	0.007	0.016	0.283	0.778
Problem-solving	–0.103	–1.805	0.072	–0.042	–0.736	0.462
Reflection with Feedback	–0.108	–1.886	0.060	–0.061	–1.062	0.289
Fidelity (realism)	–0.048	–0.831	0.406	–0.005	–0.085	0.933
Total	–0.145	–2.550	0.011	–0.018	–0.316	0.752

Legend: R–correlation coefficient between the evaluation of the scenario element and the age of the study participants

Statistical analysis revealed a weak negative correlation between age and the evaluation of objectives and information (R = –0.180; p = 0.002), support (R = –0.154; p = 0.007), and the overall evaluation of simulation assumptions (R = –0.145; p = 0.011). This indicates that as age increases, the evaluation of these

scenario elements among nursing students decreases. However, no significant relationship was found between age and the importance of scenario elements in simulation (Table 4).

No statistically significant differences were found in the evaluation of simulation assumptions based on education level. However, it was observed that the respondents with higher education rated problem-solving slightly lower, while they rated simulation realism slightly higher. The importance of scenario elements was relatively similar among the participants with secondary and higher education (Table 5).

Table 5. Evaluation of simulation assumptions according to the SDS Questionnaire among students by education level

Scale	Evaluation of scenario elements				Importance of scenario elements			
	Secondary education	Higher education	Mann-Whitney U test		Secondary education	Higher education	Mann-Whitney U test	
			Z	p			Z	p
Objectives and information	4.2 (3.7–5.0)	4.4 (4.0–5.0)	0.615	0.539	4.4 (4.0–5.0)	4.4 (4.0–5.0)	0.162	0.872
Support	4.0 (4.0–4.9)	4.0 (3.8–5.0)	–0.341	0.733	4.5 (4.0–5.0)	4.5 (4.0–5.0)	0.401	0.689
Problem-solving	4.4 (4.0–5.0)	3.3 (4.0–5.0)	1.094	0.274	4.6 (4.0–5.0)	4.4 (4.0–5.0)	0.923	0.356
Reflection with feedback	4.5 (4.0–5.0)	4.5 (4.0–5.0)	1.065	0.287	4.8 (4.0–5.0)	4.6 (4.0–5.0)	0.636	0.525
Fidelity (realism)	4.5 (4.0–5.0)	5.0 (4.0–5.0)	1.069	0.285	5.0 (4.0–5.0)	5.0 (4.0–5.0)	0.687	0.492
Total	4.4 (3.9–4.9)	4.4 (4.0–4.8)	0.668	0.504	4.6 (4.1–5.0)	4.5 (4.1–5.0)	0.652	0.514

Legend: The median (Q1–Q3) is provided for each group.

The aims and information are significantly better evaluated by nursing students who do not have children ($p = 0.041$). When evaluating the remaining elements of the scenario, no significant differences were found depending on having children. Moreover, the importance of the elements of the scenario was similar in the respondents who have and do not have children. However, it can be seen that the respondents who do not have children rated the received support slightly higher, and the reflection with feedback slightly lower (Table 6).

The students rated the realism of scenario elements the highest (Me = 5.0), while support (Me = 4.0) and objectives and information (Me = 4.2) received the lowest ratings. The most important areas identified by the respondents were realism (Me = 5.0) and reflection with feedback (Me = 4.5), while the other elements were only slightly less significant for the participants (Table 7).

Table 6. Evaluation of simulation assumptions according to the SDS Questionnaire among students based on parental status

Scale	Evaluation of scenario elements				Importance of scenario elements			
	Respondent has children	Respondent has no children	Mann-Whitney U test		Respondent has children	Respondent has no children	Mann-Whitney U test	
			Z	p			Z	p
Objectives and information	4.0 (3.4–5.0)	4.4 (4.0–5.0)	–2.047	0.041	4.4 (4.0–5,0)	4.4 (4.0–5.0)	0.105	0.916
Support	4.0 (3.8–5.0)	4.3 (4.0–5.0)	–1.322	0.186	4.5 (4.0–5.0)	4.3 (4.0–5.0)	0.350	0.726
Troubleshooting	4.4 (4.0–5.0)	4,4 (4.0–5.0)	–1.332	0.183	4.6 (4.0–5.0)	4.6 (4.0–5,0)	–0.645	0.519
Reflection with feedback	5.0 (4.0–5.0)	4.5 (4.0–5.0)	–1.385	0.166	4.8 (4.0–5.0)	4.8 (4.0–5.0)	–1.088	0.277
Fidelity (realism)	5.0 (4.0–5,0)	5.0 (4.0–5.0)	–0.324	0.746	5.0 (4.0–5,0)	5.0 (4.0–5,0)	0.151	0.880
Total	4.3 (3.8–4.8)	4.4 (4.0–4.9)	–1.701	0.089	4.6 (4.1–5.0)	4.6 (4.1–5.0)	–0.199	0.842

Legend: The median (Q1–Q3) is provided for each group.

Table 7. Overall evaluation of simulation assumptions according to the SDS Questionnaire among students

Scale	Evaluation of scenario elements					Importance of scenario elements				
	M	SD	Me	Q1	Q3	M	SD	Me	Q1	Q3
Objectives and Information	4.2	0.8	4.2	4.0	5.0	4.4	0.6	4.4	4.0	5.0
Support	4.2	0.8	4.0	3.8	5.0	4.4	0.6	4.5	4.0	5.0
Troubleshooting	4.3	0.7	4.4	4.0	5.0	4.5	0.5	4.6	4.0	5.0
Reflection with feedback	4.4	0.5	4.5	4.0	5.0	4.5	0.5	4.8	4.0	5.0
Fidelity (realism)	4.5	0.7	5.0	4.0	5.0	4.6	0.6	5.0	4.0	5.0
Total	4.3	0.6	4.4	4.0	4.8	4.5	0.5	4.6	4.1	5.0

Table 8a. Evaluation of simulation assumptions according to the SDS Questionnaire among students based on marital status

Scale	Evaluation of scenario elements				
	single	married	divorced	Kruskal-Wallis test	
				H	p
Objectives and Information	4.3 (4.0–5.0)	4.2 (3.4–5.0)	4.4 (4.0–5.0)	1,257	0.533
Support	4.0 (4.0–5.0)	4.0 (3.8–5.0)	4.3 (4.0–5.0)	0.947	0.623
Problem-solving	4.4 (4.0–5.0)	4.4 (4.0–5.0)	4.2 (4.0–5.0)	0.562	0.755
Reflection with feedback	4.5 (4.0–5.0)	4.5 (4.0–5.0)	4.5 (4.0–5.0)	1,262	0.532
Fidelity (realism)	4.5 (4.0–5.0)	5.0 (4.0–5.0)	5.0 (4.0–5.0)	0.045	0.978
Total	4.4 (4.0–4.8)	4.3 (3.8–4.9)	4.4 (3.9–4.9)	0.663	0.718

No significant differences were found in the evaluation of simulation assumptions among nursing students based on marital status. Both the evaluation of scenario elements and the importance of scenario elements were relatively similar among the participants who were single, married, or divorced (Tables 8a and 8b).

Table 8b. Evaluation of simulation assumptions according to the SDS Questionnaire among students based on marital status

Scale	Importance of scenario elements				
	single	married	divorced	Kruskal-Wallis test	
				H	p
Objectives and Information	4.4 (4.0–5.0)	4.4 (4.0–5.0)	4.4 (4.4–5.0)	1,664	0.435
Support	4.3 (4.0–5.0)	4.5 (4.0–5.0)	4.8 (4.0–5.0)	2,439	0.295
Problem-solving	4.6 (4.0–5.0)	4.6 (4.0–5.0)	5.0 (4.0–5.0)	0.872	0.647
Reflection with feedback	4.8 (4.0–5.0)	4.8 (4.0–5.0)	5.0 (4.0–5.0)	1,669	0.434
Fidelity (realism)	5.0 (4.0–5.0)	5.0 (4.0–5.0)	5.0 (4.0–5.0)	0.318	0.853
Total	4.6 (4.1–5.0)	4.6 (4.1–5.0)	4.7 (4.2–5.0)	1,251	0.535

Legend: The median (Q1–Q3) is provided for each group.

Discussion

In recent years, there has been a significant increase in the use of medical simulation as an educational tool for nursing students [2]. Simulation-based classes prepare nursing students for their future careers and patient care responsibilities [3, 4]. Nowak emphasizes that medical simulators provide a safe learning environment, allowing students to make mistakes without posing any risk to patients' health [5]. Similarly, Zieliński highlights the opportunity for students to repeatedly practice the same scenarios, enabling them to refine their skills and reinforce their knowledge [6]. Also, Pawłowski extensively discussed medical simulation in terms of repetition and the development of not only technical skills but also decision-making and communication abilities [7]. Therefore, it is essential to assess and analyze the effectiveness of medical simulation in nursing education using appropriate research tools. In this study, the effectiveness was evaluated using standardized EPQ and SDS questionnaires. Both scales are simple and relatively new tools for measuring nursing students' perceptions of the presence and importance of best educational practices. In the existing literature, the SDS and EPQ scales are recommended as professional tools primarily used for evaluating simulation experiences and the application of best simulation practices [8]. The research material collected and

analyzed in this study allows for an assessment of the effectiveness of educational methods in the context of simulation-based learning.

Our own study shows that the sociodemographic variables, such as student age, play a significant role in the evaluation of educational techniques and simulation scenarios. Analysis of the results of a study conducted by Zalewska, which included 361 students, shows similarities with the findings presented in this study [9]. Similarly, Zapko et al. found a statistically significant difference between different student cohorts and their expectations regarding the use of best educational practices [10]. Based on the results above, it can be inferred that the higher the year of study (and consequently, the age of students), the lower their evaluation of scenario elements. Additionally, the results of this study suggest that students without children rated scenario elements such as objectives and information higher. However, there is no existing scientific evidence confirming this aspect as a factor affecting simulation effectiveness. Rodriguez et al. emphasized that collaboration is a key component in the education of future medical professionals [11]. In simulation-based learning, active learning and collaboration are crucial elements that enable students to be fully engaged, utilizing their cognitive, psychological, and interpersonal skills to effectively support patients. Moreover, collaboration fosters learning through problem-solving, reflecting real-life situations. Based on these considerations, conducting the present study on student evaluation of educational techniques in the context of nursing education was well justified. Our study demonstrated that students rated collaboration-related educational techniques the highest. These findings are consistent with those of Zapko et al., who found that students considered collaboration the most important element of educational practices [10].

In the study by Khasawneh et al., conducted in the Middle East countries on a group of 370 nursing students, the participants highly rated active and diverse learning methods, collaboration, and expectations. Moreover, these factors were positively correlated with self-confidence and student satisfaction [12]. Comparing these results with the findings of the present study one can notice a convergence regarding elements such as diverse learning methods and expectations. Jeffries describes these educational techniques as supportive of learning and student satisfaction [13]. Another crucial aspect of this study was to determine whether simulation is an effective method for preparing future nurses for clinical practice. The results of the study by Zapko et al. show that simulation is based on solid educational practices and plays a key role in preparing students for their future professional careers [10]. The results of our study demonstrate consistency with the research findings of the authors above, as students rated the realism of simulations at a very high level.

Another study confirming the effectiveness of simulation in realistic clinical situations was conducted by Alshammari et al., whose findings indicated that students appreciated the practicality of simulation and their enhanced competence in applying acquired skills to clinical environments [14]. The use of medical simulation in healthcare education offers numerous advantages, including improved quality of education and training, increased patient safety, enhanced teamwork skills, and continuous professional development. These activities enable future healthcare professionals to better prepare for diverse clinical situations, directly contributing to improved quality of healthcare. Based on the above considerations, medical simulation is confirmed as an effective educational method that allows students to acquire and improve their skills in a safe and realistic environment.

Conclusions

The study showed that students rated educational techniques related to collaboration the highest, identifying this area as crucial in the educational process. Student age and parental status significantly influenced the students' evaluations of educational practices. The participants highly rated the realism of simulation, considering it an essential component of education that would significantly impact their future professional practice**.**

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