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The role of virtual medical simulation in teaching and in developing the soft skills of nursing and medical students

Izabela Sałacińska[1,2], Więch Paweł[1,2,3], Joanna Przybek-Mita[2,4,5], Marek Muster[6], Grzegorz Kucaba[7], Jacek Szczygielski[7], Ana Marreiros[8], André Mestre[8], Dariusz Bazaliński[1,2,9]

[1] University of Rzeszów, Faculty of Health Sciences and Psychology, Institute of Nursing, Rzeszów, Poland
[2] University of Rzeszów, University Centre for Research and Development in Health Sciences, Rzeszów, Poland
[3] State University of Applied Sciences, Department of Nursing, Przemyśl, Poland
[4] University of Rzeszów, Faculty of Health Sciences and Psychology, Rzeszów, Poland
[5] Postgraduate Nursing and Midwifery Education Centre, Rzeszów, Poland
[6] University of Rzeszów, Medical Simulation Center, Rzeszów, Poland
[7] University of Rzeszów, Faculty of Medicine, Rzeszów, Poland
[8] University of Algarve, Faculty of Medicine and Biomedical Sciences, Portugal
[9] Podkarpackie Specialist Oncology Centre, Specialist Hospital in Brzozów, Brzozów, Poland

Abstract

Introduction: Medical simulation is an important training tool used in the medical profession. Traditional teaching methods are not sufficient in the face of rapid changes in medicine. Body Interact (BI) is an interactive VPS software that can be operated via a touch interface. BI provides an interesting and dynamic learning environment. Although this tool has many advantages, there is still a need for further research to optimize its use.

Aim: The purpose of this study was to analyze the impact of VPS training in small groups on perceptions of individual learning and curriculum integration among nursing and medical students.

Material and methods: Baseline perceptions of individual learning process and curricular integration were assessed using a 27-item pre-session questionnaire. Students subsequently participated in small-group VPS training sessions lead by a clinical tutor and then completed a 32-item post-session questionnaire, including 25 paired items. Pre- and post-session responses were compared to determine the impact of the small-group VPS experience.

Results: Analysis of the differences between the pre-session and post-session Assessments of curricular needs showed a negative difference between the results identified in the group of students doing Bachelor's course in nursing a minimal difference, approaching zero, in the group doing Master's

course in nursing and a highly positive difference in the group doing Master's course in medicine. Statistically significant post-hoc differences were shown between the groups doing Bachelor's course in nursing and Master's course in medicine.

Conclusions: The survey showed that nursing students had high expectations for simulation training that allowed them to develop soft skills and improve their professional skills. The nursing group was more satisfied with the level of training than the medical group.

Key words: virtual patient simulator; curricular integration; simulation training; clinical education; high-fidelity simulation

Introduction

Medical simulation is an advanced teaching tool and has for many years been used as an important aid in the training process in health professions. The traditional teaching models, which mainly focus on the transmission of knowledge, appear to be insufficient given the increasing pace of change in medicine. Initially, simulations applied simple phantoms, and that was followed by advanced patient simulators, software for high-fidelity simulation systems and virtual patient simulators (VPS) for clinical settings, which created opportunities for communication and virtual patient assessment [1, 2]. Body Interact (BI) is an interactive VPS software package that is operated via a touchscreen interface. It can be used without any additional medical equipment, and without a model, actor or the simulated patient. Like high-fidelity simulators (HFS), the VPS provides an opportunity to apply acquired knowledge in a low-risk setting and to integrate the knowledge of the basic science with clinical competences [3]. It provides an interesting and dynamic learning environment in which students can take on the role of a medical professional managing a virtual patient, making decisions and administering therapeutic interventions. Furthermore, it allows students to consolidate their skills needed for performing the medical interview and physical examination, and to make real-time observations of the medical procedures performed. Although the tool presents considerable advantages and seems to be attractive for educational purposes, there is a lack of Polish research investigating the VPS and its practical value in education of medical and nursing students [4, 5].

Material and methods

The present study used the data collected in the original article "The impact of small-group virtual patient simulator training on perceptions of individual learning

process and curricular integration: a multicentre cohort study of nursing and medical students" BMC Medical Education (2022) [6]. The project was conducted in the Medical Simulation Centre at the University of Rzeszów. The group of participants of the Polish part of the project included 76 medical students and 119 nursing students doing their respective courses at the University of Rzeszów. The research project was conducted in the frames of three courses: Physical examination and Intensive care (groups doing Bachelor's course and Master's course in nursing, respectively) as well as Neurosurgery (group doing Master's course in medicine). The students perceptions were collected using the VPS Study Instrument previously validated and published (Mestre et al.). The pre-session questionnaire–U0–consisted of 27 questions from U0.1 to U0.27 was completed via an online form. A detailed description of the table and questions are in original article Mestre and Muster et al. (2022) [6]. After the session, participants completed the post-session questionnaire–U1 consisted of 32 questions from U1.1 to U1.32 (Mestre et al.). The research tool was divided into three parts making it possible to collect data for the following dimensions: 1) Assessment of individual learning difficulties of the specific students; 2) Assessment of curriculum related needs; 3) Perception of the VPS as a learning aid intended to fill in the educational gaps. The pre-session questionnaire contained 27 items (part I and II), whereas the post-session questionnaire consisted of 32 items (part III and IV). The two tools contained 25 paired items, to enable comparative analysis of the pre- and post-session responses as well as assessment of the impact produced by the VPS experience on the learning process of nursing and medical students in Poland. Two items were exclusive to the pre-questionnaire (U0.7 and U0.8) and seven items were exclusive to the post-questionnaire (U1.26 to U1.32). The study protocol and implementation of the questionnaires have been described in the main article [6]. Approval of the bioethics commission was acquired before the study began.

Statistical analysis

The statistical analyses were computed using IMB SPSS STATISTIC, version 24iR. The reliability coefficient of the questionnaire was assessed using Cronbach's alpha, and statistical significance was determined using the Kruskal-Wallis test, which rejected the null hypothesis at $p < 0.01$. The analyses took into account the paired items that were considered statistically significant when the null hypothesis was rejected. The remaining unpaired items were subjected to descriptive analysis and correlations were determined using Pearson's correlation coefficient.

Results

A total of 195 students of the University of Rzeszów participated in the study, including 119 nursing students and 76 medical students. The survey questionnaire was used to obtain answers to questions about the learning process and the approved curriculum for both courses of study.

Pre-session questionnaire

One of the first item (U0.2) asked about a focus on theory in the educational process, and produced an average score of 5.72 on a 7-point Linkert scale, and medical students were more likely than nursing students to report they focused on theory in their learning process. Similar results were obtained for the item relating to the balance between the theoretical knowledge and its practical application in the course of study (U0.3), and nursing students rated their course as more balanced ($M = 4.71$; $SD = 1.44$) compared to medical students ($M = 4.91$; $SD = 1.48$). Nursing students emphasised that through the training they developed soft skills, including communication skills, and gained the ability to build a professional image, and to perform activities at work with confidence, and they acquired skills needed for group management and conflict resolution (U0.4, U0.5, U0.6). Additionally, they were more likely than medical students to indicate that the simulation activities and clinical experience were appropriately matched to their level of knowledge ($p < 0.001$) (U0.7, U0.8). Integration of the educational curricula was also assessed and the scores on a 7-point Likert scale ranged between 2 and 7. According to the students' rating, (U0.9) the nursing courses were more integrated than the medical course ($M = 5.84$; $p < 0.001$). Both groups showed high expectations related to the VPS training as regards its usefulness for increased learning effectiveness ($M = 5.56$; $SD = 1.31$), and as a tool in the clinical decision-making process ($M = 6.55$; $SD = 1.10$), which also makes it possible to modify the therapeutic process, where decision-making errors provide opportunities for applying different procedures and can be transformed into a constructive learning process ($M = 6.8$; $SD = 1.01$) (U0.10, U0.11).

The effectiveness of the VPS training was assessed based on students' responses to paired items, provided before and after the simulation session. The results of the survey demonstrated significant improvements in the learning process, especially in the use of theoretical knowledge for practical clinical application ($p < 0.001$), and development of communication skills ($p < 0.001$) as well as group management and conflict management skills ($p < 0.001$) (U1.3–U1.6). It is noteworthy that students who selected the lowest ratings before the VPS session tended to selects the highest

values after the session, which resulted in a negative correlation between the scores before and after the VPS training ($p < 0.001$). Gains were found in the opinions about the integration of educational curricula, and positive effects were shown in the evaluation of opportunities for practical learning in specific clinical situations, the possibility to participate in medical simulation, and to improve communication skills as well as conflict and group management skills ($p < 0.001$). The assessment also showed that the VPS training favourably affects professional confidence ($p < 0.001$) (U1.12). Overall impressions of all those participating in the VPS training sessions were positive. The students reported high levels of satisfaction with the use of the VPS for learning ($M = 6.68$; $SD = 1.02$), with the use of the technology resource ($M = 6.78$; $SD = 1.01$), and the BI VPS itself ($M = 6.71$; $SD = 1.02$) (U1.16, U1.17) It appears that the VPS, used as an educational tool, affects the learning process by making it possible to fill in the gaps in one's knowledge ($M = 6.48$; $SD = 1.04$), to obtain feedback related to the learning process ($M = 6.69$; $SD = 1.00$), and to identify weaknesses in one's competences ($M = 6.70$; $SD = 0.90$). The VPS also provided opportunities to practice various clinical decision-making strategies, and to see consequences of such decisions ($M = 6.58$; $SD = 1.01$); owing to this it was an effective tool for correcting erroneous clinical decisions and learning from one's own mistakes ($M = 6.8$; $SD = 0.80$). According to the study participants, the VPS was an important teaching tool ($M = 6.62$; $SD = 1.01$) which allowed them to develop and improve communication skills ($M = 5.32$; $SD = 1.30$), decision-making skills ($M = 6.67$; $SD = 1.01$), self-directed learning skills ($M = 6.47$; $SD = 1.03$), as well as reasoning and critical thinking ($M = 6.76$; $SD = 0.85$), which as a result allowed them to get constructive feedback ($M = 6.76$; $SD = 0.86$), made it possible for them to handle specific clinical cases ($M = 6.75$; $sd = 0.88$) and to gain better understanding of the complexity of the therapeutic process in specific clinical situations (U1.26–U1.32).

Table 1 presents descriptive statistics for the results achieved by the students in the five measurements: *I Assessment of weaknesses in individual student learning–PRE, II Assessment of curricular needs–PRE, III Assessment of weaknesses in individual student learning–POST*, *IV Assessment of curricular needs–POST*, *V Perception of the VPS as a learning tool and to fill gaps in student learning;* it also shows differences in the PRE and POST measurements, i.e., III–I and IV–II. All the results are shown separately for three groups.

The results of the *Assessment of weaknesses in individual student learning* before and after the training differed significantly in each of the investigated groups: physical examination ($p = 0.006$), intensive care ($p = 0.001$) and neurosurgery ($p = 0.001$). The mean Post-session results were higher compared to the Pre-session results in each group (Table 2).

Table 1. Overall results acquired by the students

Likert Scale [1–7 points] N		Basic descriptive statistics							
		χ	Me	Min	Max	Q I	Q III	SD	
Bachelor's in nursing									
Pre	I	51	5.31	5.27	2.20	7.00	4.80	6.13	1.05
	II	51	5.93	6.00	2.58	7.00	5.58	6.75	0.93
Post	III	51	5.63	5.67	3.87	7.00	4.93	6.33	0.91
	IV	51	5.78	6.00	2.67	7.00	5.17	6.58	1.04
	V	51	5.99	6.00	4.27	7.00	5.20	6.80	0.83
Difference	III–I	51	0.32	0.33	–2.04	2.60	–0.07	0.67	0.79
	IV–II	51	–0.15	0.00	–2.00	2.58	–0.50	0.17	0.85
Master's in nursing									
Pre	I	68	5.08	5.17	1.53	7.00	4.40	6.00	1.12
	II	68	5.66	5.92	2.20	7.00	5.08	6.38	0.99
Post	III	68	5.37	5.47	2.93	7.00	4.60	6.07	1.04
	IV	68	5.74	6.00	3.33	7.00	4.96	6.67	1.07
	V	68	5.97	6.17	3.20	7.00	5.43	6.67	0.90
Difference	III–I	68	0.30	0.25	–1.27	2.80	–0.13	0.53	0.71
	IV–II	68	0.07	0.08	–2.25	3.38	–0.25	0.33	0.81
Master's in medicine									
Pre	I	76	4.15	4.07	1.73	7.00	3.23	4.90	1.14
	II	76	5.88	6.08	2.92	7.00	5.21	6.63	0.92
Post	III	76	4.49	4.30	2.20	7.00	3.63	5.40	1.19
	IV	76	6.40	6.75	2.58	7.00	6.13	7.00	0.97
	V	76	6.58	6.80	3.07	7.00	6.53	7.00	0.69
Difference	III–I	76	0.34	0.20	–1.73	3.20	–0.20	0.80	0.82
	IV–II	76	0.52	0.67	–4.00	2.75	0.00	1.00	1.06

Legend: – number of observations; χ–arithmetic mean; Me–median; Min–minimum; Max–maximum; Q1–lower quartile; Q3–upper quartile; SD–standard deviation

Table 2. Comparison of the results in the Assessment of weaknesses in individual student learning, Pre and Post, separately for three groups

	Pre I		Post III		t	p
	χ	SD	χ	SD		
Bachelor's in nursing	5.31	1.05	5.63	0.91	–2.89	0.006
Master's in nursing	5.08	1.12	5.37	1.04	–3.43	0.001
Master's in medicine	4.15	1.14	4.49	1.19	–3.62	0.001

Legend: t–value of Mann-Whitney U test; p–probability value, χ–arithmetic mean, SD–standard deviation

A comparison of the results of the pre- and post-session *Assessments of curricular needs*, separately in three groups, showed significant differences in the group of medical students ($p < 0.001$). The participants in this group acquired higher mean results in the assessments after the training, relative to the measurement before the training (Table 3).

Table 3. Comparison of the results in the *Assessment of curricular needs.* Pre and Post, separately for three groups

	Pre II		Post IV		t	p
	χ	SD	χ	SD		
Bachelor's in nursing	5.93	0.93	5.78	1.04	1.27	0.212
Master's in nursing	5.66	0.99	5.74	1.07	–0.74	0.463
Master's in medicine	5.88	0.92	6.40	0.97	–4.26	< 0.001

Legend: t–value of Mann-Whitney U test; p–probability value, χ–arithmetic mean, SD–standard deviation

The differences in the results of pre-session and post-session *Assessments of weaknesses in individual student learning* were compared in the three groups. The analysis showed no statistically higher or lower differences between these assessments in any of the groups relative to the remaining groups ($p = 0.939$) (Table 4).

Table 4. Comparison of the differences between the Pre-session and Post-session Assessments of weaknesses in individual student learning

	Bachelor's in nursing		Master's in nursing		Master's in medicine	
	χ	SD	χ	SD	χ	SD
III–I	0.32	0.79	0.30	0.71	0.34	0.82
p	F = 0.06; p = 0.939					

Legend: F–value of Fischer's F-test (one-way analysis of variance ANOVA); p–probability value, χ–arithmetic mean; SD–standard deviation

Analysis of the differences between the pre-session and post-session *Assessments of curricular needs* showed a negative difference between the results identified in the group of students doing Bachelor's course in nursing (–0.15 ± 0.85), a minimal difference, approaching zero, in the group doing Master's course in nursing (0.07 ± 0.81), and a highly positive difference in the group doing Master's course in medicine (0.52 ± 1.06). The differences in the three groups were not the same ($p < 0.001$). Statistically significant post-hoc differences were shown between the groups doing Bachelor's course in nursing and Master's course in medicine ($p < 0.001$) (Table 5).

Table 5. Comparison of the differences between the Pre-session and Post-session Assessments of curricular needs

	Bachelor's in nursing		Master's in nursing		Master's in medicine	
	χ	SD	χ	SD	χ	SD
IV–II	k–0.15	0.85	0.07	0.81	0.52	1.06
p	F = 8.79; p < 0.001					
Post-hoc	Bachelor's in nursing		Master's in nursing		Master's in medicine	
Physical examination			0.396		< 0.001	
Intensive care	0.396				0.011	
Neurosurgery	< 0.001		0.011			

Legend: F–value of Fischer's F-test (one-way analysis of variance ANOVA), post-hoc: Tukey's test; p–probability value, χ–arithmetic mean; SD–standard deviation

Discussion

In recent years, medical simulation has become one of the priority methods for teaching in healthcare related courses of study. Medical simulation provides an approximation of clinical setting that requires students to take appropriate actions in the face of changing conditions, and to respond to problems as they arise, in the same way as in real life. The use of simulation makes it possible to more effectively prepare students to enter the real clinical settings and to interact with the real patient. Soft skills such as stress management, and the ability to communicate with team members, or to give clear instructions or listen to members of the therapeutic team are extremely important in the daily work of health professionals.

The present study focused on the use of the BI VPS in the educational process and on testing the soft skills and their improvement. Despite the noticeable gains resulting from the use of this tool, so far few studies have evaluated the integration of this tool into the training process intended for health professions. A study by Padilha et al., which involved a group of nursing students, showed that the VPS is easy to use and suitable for the learning process [1]. Another randomised study showed an increase in clinical reasoning and knowledge consolidation in students participating in a VPS-aided training session compared to a group of students using low-fidelity simulation [7]. Similar findings were reported by Watari in a study involving a group of medical students in Japan, in which he showed that participation in a single BI VPS session improved knowledge and clinical reasoning [8]. Similar results were reported by other authors [9, 10]. Favourable opinion about this educational tool, reported by nursing students, was also shown by Tjoflat et al. whereas Gu et al. reported improved knowledge-related scores when the VPS training was added to the core

clinical programme [11, 12]. The study in a group of nursing and medical students at the University of Rzeszów is consistent with studies by other researchers showing greater effectiveness in knowledge acquisition, individual pace of learning and integration of the curriculum [13, 14]. The students greatly appreciated the opportunity to learn from their mistakes without negative consequences for the patient and to see the consequences of clinical decisions, which is consistent with other studies in which students participated in virtual simulation training [15, 16]. Another gain was related to the practice of soft competences, in particular the abilities of effective communication, negotiation, as well as conflict resolution and group management. The teaching process was carried out in small groups which may also have favourably impacted student satisfaction and effectiveness of the VPS training. A study by Edmunds and Brown showed that the training environment of a small group contributes to students' involvement in learning, makes it possible to more rapidly identify the learner's weaknesses, stimulates teamwork and also encourages the development of soft skills [17].

The VPS training was perceived to increase effectiveness of one's learning process, to contribute to the curriculum integration and to enable improvement in non-technical competences. Students who awarded the lowest rating to the integration of the curriculum prior to the VPS session, tended to benefit the most from attending the VPS training. The study focused on the results and subjective assessment of the students and no long-term evaluation was carried out taking into account knowledge, analysis and clinical reasoning or the development of non-technical skills. This may provide a direction for future research focusing on advanced tools supporting the process of training nurses and medical professionals.

Conclusions

The present findings show that the students' expectations related to the VPS training were high, with regard to such factors as the effectiveness of learning and clinical decision-making, and the possibility to modify the therapeutic process, where erroneous decisions provided grounds for changing the procedure applied. According to nursing students, the medical simulation training allowed them to develop soft skills, including communication skills, and to gain the ability to build a professional image, and to perform activities at work with confidence, and finally to acquire skills needed for group management and conflict resolution. In the entire study group, the nursing students were more likely than medical students to indicate that the simulation training and clinical experience were appropriately matched to their level of knowledge.

Limitations

The study did not include quantitative assessment of the knowledge gained as a result of the VPS session, nor did it evaluate long term effects of the training. Another limitation of the study lies in the fact that the VPS was not compared, in terms of effectiveness, to low, medium or high fidelity simulation. Furthermore, the study did not investigate effectiveness of learning in small groups, large groups or individually, nor did it compare the effectiveness of the VPS training during the first years of study (pre-clinical course) in relation to the final years of study (clinical training).

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