

## Effect of clinical simulation on the knowledge retention of nursing students

Efeito da simulação clínica na retenção do conhecimento de estudantes de enfermagem  
 Efecto de la simulación clínica en la retención de conocimientos de estudiantes de enfermería

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**How to cite:**

Araújo MS, Medeiros SM, Costa RR, Coutinho VR, Mazzo A, Sousa YG. Effect of clinical simulation on the knowledge retention of nursing students. Acta Paul Enferm. 2021;34:eAPE000955.

**DOI**

<http://dx.doi.org/10.37689/acta-ape/2021A0000955>

**Keywords**

Simulation technique; Emergencies; Knowledge; Students, nursing; Primary Health Care

**Descritores**

Simulação; Emergências; Conhecimento; Estudantes de enfermagem; Atenção Primária à Saúde

**Descriptores**

Simulación; Urgencias médicas; Conocimiento; Estudiantes de enfermería; Atención Primaria de Salud

**Submitted**

April 27, 2020

**Accepted**

March 23, 2021

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**Abstract**

**Objective:** To identify the effect of clinical simulation on the immediate and retained cognitive performance of students in a vocational course in nursing about their performance in emergencies in Primary Health Care.

**Methods:** This is an intervention study, of before and after type, carried out with 46 students of a vocational course in nursing. Students were allocated into two groups: control and experimental. The control group had access to a theoretical class with demonstration of skill. The experimental group had access to a simulation session with four scenarios. In addition to the sociodemographic characterization, students responded to a knowledge test in three moments, namely: pre-test, immediate post-test and late post-test (after 30 days). A significance level of 5% was adopted, using the Mann-Whitney and Kruskal Wallis tests,

**Results:** There was a statistical difference between the medians of control and experimental groups in the late post-test ( $p$  value=0.038), thus students in the experimental group retained more knowledge than those in the control group.

**Conclusion:** Learning from clinical simulation conferred higher scores and retention of knowledge compared to those acquired through an expository class with demonstration of skills.

**Resumo**

**Objetivo:** Identificar o efeito da simulação clínica no desempenho cognitivo imediato e retido de estudantes do curso técnico de enfermagem acerca da atuação nas emergências na Atenção Primária à Saúde.

**Métodos:** Estudo de intervenção, do tipo antes e depois, realizado com 46 estudantes do curso técnico em enfermagem. Estes foram alocados em dois grupos: controle e experimental. O grupo controle teve acesso a uma aula teórica com demonstração de habilidade. O grupo experimental teve acesso a sessão de simulação com quatro cenários. Além da caracterização sociodemográfica, os estudantes responderam a um teste de conhecimento em três momentos, a saber: pré-teste, pós-teste imediato e pós-teste tardio (após 30 dias). Adotou-se um nível de significância de 5%, através da utilização do teste de Mann-Whitney e de *Kruskal Wallis*,

**Resultados:** Houve diferença estatística entre as medianas do grupo controle e experimental no pós-teste tardio ( $p$  valor = 0,038), dessa forma, os estudantes do grupo experimental retiveram mais conhecimento que os do grupo controle.

**Conclusão:** A aprendizagem a partir da simulação clínica conferiu scores e retenção do conhecimento maiores comparados àqueles adquiridos por meio de aula expositiva com demonstração de habilidades.

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Conflicts to interest: nothing to declare.

## Resumen

**Objetivo:** Identificar el efecto de la simulación clínica en el desempeño cognitivo inmediato y retenido de estudiantes de la carrera técnica de enfermería sobre la actuación en emergencias en la Atención Primaria de Salud.

**Métodos:** Estudio experimental, tipo antes y después, realizado con 46 estudiantes de la carrera técnica de enfermería. Los participantes fueron separados en dos grupos: de control y experimental. El grupo de control tuvo una clase teórica con demostración de habilidades. El grupo experimental tuvo una sesión de simulación con cuatro escenarios. Además de la caracterización sociodemográfica, los estudiantes respondieron una prueba de conocimiento en tres momentos, a saber: pretest, posttest inmediato y posttest tardío (después de 30 días). El nivel de significación adoptado fue del 5 %, mediante la utilización de la prueba de Mann-Whitney y de Kruskal-Wallis.

**Resultados:** Se observó diferencia estadística entre las medianas del grupo de control y experimental en el posttest tardío ( $p$  valor = 0,038). De esta forma, los estudiantes del grupo experimental retuvieron más conocimientos que los del grupo de control.

**Conclusión:** El aprendizaje a partir de la simulación clínica demostró una mayor puntuación y retención de conocimientos comparado con los adquiridos mediante la clase expositiva con demostración de habilidades.

Brazilian Clinical Trials Registry (ReBEC): UTN: U1111-1236-9025

## Introduction

Primary Health Care (PHC), since 2006, through the elaboration of the Brazilian National Emergency Care Policy (PNAU - *Política Nacional de Atenção às Urgências*) is considered a gateway to the first emergency care, with the perspective of decentralizing care and increasing patient survival. This definition was made considering, mainly, the health units' geographic distribution and the need for speed of care.<sup>(1)</sup>

However, even though PNAU was enacted more than a decade ago, in some contexts, there is still a centrality in the level of tertiary care in approaching critically ill patients, which brings the need for reflections on this issue.<sup>(1,2)</sup>

A study demonstrated that professionals' knowledge is weakened in the scope of urgency and emergency; that in PHC professionals generally do not recognize themselves as responsible for these disorders and that the units have a deficiency in physical and material structure, which worsens patients' prognosis and creates an overload of other services in the service network.<sup>(3)</sup>

In the context of nursing, several studies point to a gap in knowledge and aptitude<sup>(4,5)</sup> which generally contributes to the lack of problem solving. Many professionals feel insecure and report that they performed care related to the topic for the first time, on patient himself, without even having had the experience of training in laboratory environments.<sup>(6)</sup> Thus, the fragility of knowledge about the initial protocols for emergency care contributes to

the increase in patient mortality, in the overcrowding of secondary and tertiary services and in the costly health expenditures. With this, education has the most effective strategy to reduce this problem.

Among the professionals who make up the body of health, nursing stands out in quantitative terms; nursing technicians (NT) correspond to 80% of the class, which generates the need for reflections on the impacts of care practice that they have been performing and the training to which they are being exposed.<sup>(7)</sup> In the context of PHC, this reality does not differ, NTs represent a professional quantitative signifier, which presumes the need to verify the knowledge and conduct of these workers in the face of emergencies in this context.

It is known that the correct choice of educational technologies and teaching and learning strategies during the training process can determine the success or failure of learning, whether in the context of academic training and/or continuing education. When considering its relevance and applicability in health education, researchers suggest that health professionals and education and training institutions use simulations in the education of their students and in training.<sup>(8,9)</sup>

Corroborating this orientation, studies have demonstrated the contribution of simulation in several clinical areas, as well as in cognitive and psychomotor development.<sup>(8,10)</sup> Furthermore, it is known that simulation helps in the consolidation of knowledge, in the development of techniques, in relational skills, in thinking, in reflection, as well as in professional development.<sup>(8,11,12)</sup>

In the national and international context, few studies have focused on studying the formation of NT and, more precisely, clinical simulation in vocational secondary education, even though, in the Brazilian context, weaknesses in this formation are recognized.<sup>(13)</sup>

In this research, cognitive performance is related to the knowledge acquired, based on the Miller Pyramid. In this way, it is assessed how students relate the previous knowledge with the new ones; it is considered that knowledge is a premise for students to advance at other levels, such as “know how”, “show how” and “do”.

In this context, the objective was to identify the effect of clinical simulation on the cognitive performance of students in a vocational course in nursing about their performance in emergencies in PHC.

## Methods

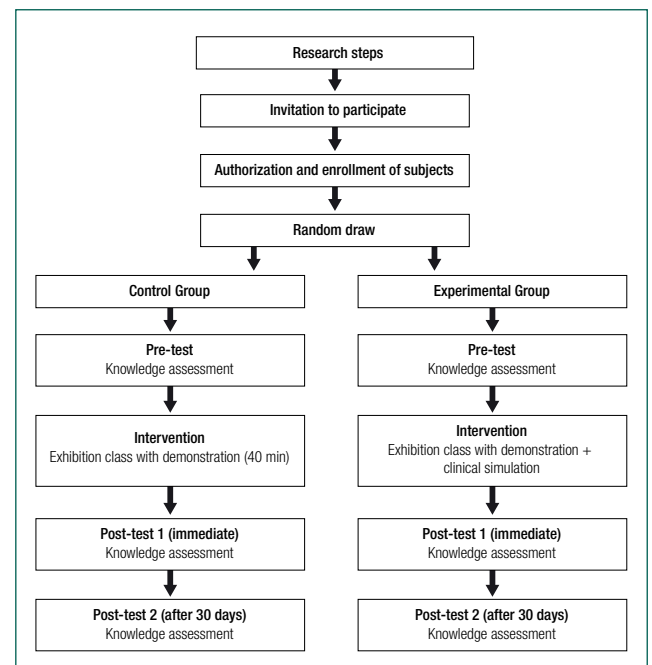
This is an intervention study, with a quantitative approach comprised of three phases. A pre-test, immediate post-test and late post-test non-equivalent control group design was used. The study was developed at a federal public university between September and November 2019.

Students of a vocational course in nursing at the institution participated in the study. It is noteworthy that the institution operates in training at a vocational, higher and postgraduate level. Through a non-probabilistic sampling process for convenience, 46 students participated in this study.

The course was disseminated in the five classes of the vocational course in nursing. Students regularly enrolled in the institution, who were present during the application of the research instruments and interventions, were included. Those who missed interventions and those who had professional experience in the health field were excluded from the study.

Subsequently, those interested in the course manually filled out the available registration form. The form contained data relating to name, telephone, email, and some preliminary information about students' proximity to the topic addressed.

Initially, the research objectives were presented to students. Through individual concession, a sociodemographic characterization instrument was applied, with the following variables: sex, age and “studied Basic Life Support (BLS) previously”. Subsequently, subjects' enrollment was carried out, with students being distributed, by lot, in the control group and in the experimental group. Figure 1 outlines the methodological path that was followed.



**Figure 1.** Flowchart of the research methodological steps

The knowledge assessment had 10 multiple-choice questions regarding the contents of basic life support. For each question, the value of 1 point was adopted, obtaining the maximum number of correct answers for students who obtain 10 points. Moreover, for each question, students checked the option that defines the level of certainty that he had at the time of resolving the question.

The knowledge assessment was built by the researchers after conducting a survey of literature and international protocols of the American Heart Association (AHA) on the most updated BLS up to the date of data collection. After this stage, it was applied, through a pilot test, to make adjustments to the semantics and clarity of content. There were no suggestions for changes. Subsequently, it

was applied in three moments: pre-test and immediate post-test and late post-test (after 30 days of intervention).

The control group participated in the theoretical-practical course of Basic Life Support with an emphasis on PHC, with a methodological strategy of an expository class with demonstration of skills. The experimental group, on the other hand, participated in the same course, however, with the lecture strategy with demonstration of skills and clinical simulation.

To carry out a simulation, the NLN Jeffries Simulation theory for nursing teaching was followed.<sup>(14)</sup>

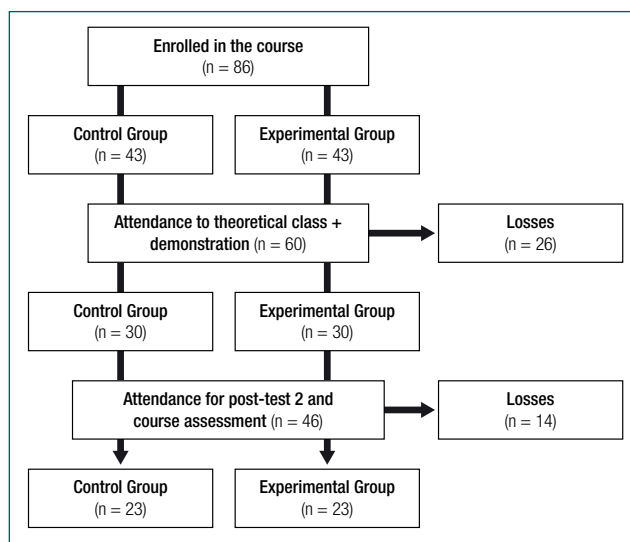
Simulation scenarios were built and executed previously, in order to investigate possible failures and make adaptations to the drawings. Each scenario had a learning objective related to experiencing a situation of cardiopulmonary arrest in adults, pregnant women and a choking situation, preceded by CRP in the PHC context. All scenarios contained the following aspects: 1) general and specific objective; 2) skills and abilities; 3) materials; 4) case description; 5) guiding questions for debriefing; 5) checklist for monitoring practical performance. It should be noted that the checklist was created with the sole purpose of assisting researchers in conducting the debriefing; the results of students' practical performance were not considered for the study.

A pilot test was carried out, in addition to previous team training for data collection. For the development of simulations, low-fidelity mannequins, which are static simulators, and simulated patient, who are trained actors to act and reproduce user behaviors in different situations and health care establishments, were used.<sup>(11)</sup> Thus, each scenario was conducted by a facilitator who, right after the closing, performed the debriefing.

After testing the scenarios and instruments, the course started with four simulation scenarios, each lasting 30 minutes, with the following schedule: 5 minutes for the briefing, 5 minutes for the action and 20 minutes for debriefing.

From the first moment - expository class with demonstration of skills - losses of study subjects were observed. Of the 86 enrolled, 60 attended the theoretical class. Students were divided by lot,

so that the control group (30) and the experimental group (30) were homogeneous. At the time of collecting the late post-test, there were other losses (14). These can be viewed in the flowchart below:



**Figure 2.** Flowchart of initial and final sample and study losses

### Data analysis and treatment

The variables used in the study are: sex, age, school performance index and knowledge. For categorical variables, relative and absolute frequency were used, and for scalar variables, measures of central tendency. The collected data were inserted into a spreadsheet of Statistical Package for the Social Sciences (SPSS), version 20.0, with descriptive and inferential analysis. Thus, in inferential statistics, to determine the measures of effect, statistical significance and confidence intervals, the Mann-Whitney tests were applied for comparisons between groups, considering that the two independent samples are of a non-normal character, resulting in the need the use of non-parametric tests, and for associations using the age range and for intragroup analysis, the Kruskal Wallis test was used. Results with  $p \leq 0.05$  were considered significant.

The study took into account the guarantee of the ethical and legal principles that govern research in human beings, recommended in Resolution 466/2012 of the Brazilian National Health Council (CNS – *Conselho Nacional de Saúde*) of the Ministry of Health, being submitted and approved

by an Institutional Review Board, under Protocol 3,305,558 and CAAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 09905819.0.0000.5537. After approval, the study was registered on the Brazilian Clinical Trials Registry platform, under protocol REQ: 8480, number UTN: U1111-1236-9025.

It is important to highlight that, after completing the research, the researchers invited students from the control group to a session of simulated clinical experiments. In the opportunity, students were able to experience the simulated scenarios previously worked only among students of the experimental group.

## Results

46 students participated in the present study, predominantly female (69.6%) and aged between 16 and 25 years (63%) and who had not studied basic life support in the regular grade of a vocational course (76.9%). Using the chi-square test, the groups were homogeneous ( $p$  value  $\geq 0.05$ ) (Table 1).

**Table 1 .** Sociodemographic characterization of the sample

Variables	Control n(%)	Experimental n(%)	Total n(%)
Sex			
Female	19(59.4)	13(40.6)	32(69.6)
Male	4(28.6)	10(71.4)	14(30.4)
Total	23	23	46(100.0)
Age group			
16 to 25 years old	13(44.8)	16(55.2)	29(63.0)
26 to 35 years old	5(62.5)	3(37.5)	8(17.4)
36 to 45 years old	3(50.0)	3(50.0)	6(13.0)
From 46 years old	2(66.7)	1(33.3)	3(6.5)
Total			46(100.0)
Studied BLS in the course			
No	18(52.9)	16(47.1)	34(73.9)
Yes	5(41.7)	7(58.3)	12(26.1)
Total	23	23	46(100.0)

n - absolute frequency; % - relative frequency; BLS - Basic Life Support

To identify and compare the knowledge scores about the teaching of basic life support in the context of PHC between the control and experimental groups, an instrument related to the assessment of

knowledge was applied in three moments: pre-test (before intervention), post-test 1 (immediately after intervention) and post-test 2 (after 30 days of intervention).

Table 2 shows the results of the Mann-Whitney test performed to test whether there were differences between the medians of the control and experimental groups, according to the knowledge assessment at the three moments. At the significance level of 5%, the rejection of the hypothesis that the medians of the groups are equal, i.e., there is evidence that there is a difference between the median of the control group and the experimental group in the post-test 2 ( $p < 0.05$ ).

As for the pre-test and post-test 1, the results did not reveal any statistical difference between the medians of the groups; students in the experimental group retained more knowledge when compared to those in the control group.

**Table 2 .** Comparison of cognitive performance between the control and experimental groups, in the pre-test, post-test 1 and post-test 2

Moment	Group	Mean	Median	SD	Min	Max	<i>P</i> value*
Pre	Control	3.7	4.0	2.1	1.0	8.0	0.470
	Experimental	4.2	4.0	2.0	1.0	8.0	
Post 1	Control	7.7	8.0	1.3	5.0	10.0	0.103
	Experimental	7.1	7.0	1.4	4.0	9.0	
Post 2	Control	5.9	6.0	1.9	1.0	9.0	0.038
	Experimental	6.8	7.0	1.3	3.0	8.0	

SD - Standard deviation; Min - minimum; Max - maximum; \* Mann-Whitney test

In addition to the comparison between the control and experimental groups, an intragroup analysis was carried out - using the Kruskal Wallis and Dunn tests - with the aim of verifying whether there was a statistical difference between the medians of the three moments (pre-test, post-test 1 and post-test 2) within each group. Thus, there was statistical significance in the three moments of the control group, considering that in the pre-test the medians were low, in the post-test 1 they increased significantly and in the post-test 2, they decreased. In the experimental group, there was significance in the pre-test and in the post-test 1, not in the post-test 2; in the pre-test the medians were low, in the post-test 1 they increased considerably and in the post-test 2 they remained high ( $p > 0.05$ ). In Table 3, anal-



**Table 3.** Association of knowledge assessment with the variables “studied Basic Life Support previously” and “age group” in the pre-test, immediate post-test and late post-test between control and experimental groups

Moment	Variables	Mean	Median	SD	P value		Mean	Median	SD	P value	
<b>Studied BLS</b>											
Control	Pre	No	28.7	27.0	11.5	0.500*	Experimental	28.4	27.0	7.9	0.191*
		Yes	25.0	27.0	3.4			31.9	29.0	5.7	
	Post 1	No	41.4	41.5	8.9	0.478*		44.8	45.0	7.8	0.253*
		Yes	39.8	34.0	10.0			48.9	48.0	6.3	
	Post 2	No	37.7	37.5	6.6	0.736*		46.5	48.0	6.8	0.639*
		Yes	39.0	37.0	10.7			48.3	48.0	7.4	
<b>Age group</b>											
Control	Pre	16 to 25	28.7	28.0	7.5	0.275#	Experimental	28.9	28.0	7.5	0.434#
		26 to 35	25.6	27.0	8.3			35.7	39.0	9.5	
		36 to 45	34.7	24.0	22.0			26.7	27.0	1.5	
		≥ 46	18.0	18.0	8.5			28.0	28.0	-	
	Post 1	16 to 25	41.6	41.0	10.2	0.919#		45.7	45.5	7.6	
		26 to 35	39.8	35.0	8.9			48.0	48.0	7.0	
		36 to 45	40.3	42.0	6.7			49.3	52.0	7.4	
		≥ 46	42.0	42.0	8.5			36.0	36.0	-	
	Post 2	16 to 25	38.7	39.0	8.6	0.935#		47.4	48.0	6.8	
		26 to 35	36.2	36.0	8.0			48.0	48.0	4.0	
		36 to 45	36.7	37.0	3.5			47.7	52.0	10.2	
		≥ 46	39.5	39.50	45.0			37.0	37.0	-	

BLS - Basic Life Support; SD - standard deviation; \* Mann-Whitney test; # Kruskal Wallis test

ysis, through the Mann-Whitney Test and Kruskal Wallis, has been demonstrated of the possible relationship between the acquisition and retention of knowledge with the following variables: studied Basic Life Support (BLS) previously and age group. The results pointed to the non-relationship of these variables ( $p > 0.05$ ).

## Discussion

In the present study, students' cognitive performance was verified through knowledge assessment, applied in three moments: pre-test, immediate post-test and after 30 days of intervention. The knowledge of students examined, both in the control and experimental groups, proved to be similar in the pre-test and in the immediate post-test.

In the pre-test, both groups had low means (control group: 3.7 points; and experimental group: 4.2 points). After interventions in both groups, the means increased significantly.

Results of a study<sup>(15)</sup> corroborated with those presented here where training in cardiopulmonary resuscitation (CPR) and clinical simulation for high school students from a public and a private school was observed, in students' learning, signifi-

cant improvement in both the immediate and late post-tests.<sup>(15)</sup>

Furthermore, the present study also identified that there was a statistical difference between the medians of the control group and the experimental group in the post-test 2 ( $p < 0.05$ ). As a result, it is clear that students in the experimental group maintained, after 30 days, a significant improvement in knowledge. Such results confirm those found in several studies that assessed the knowledge retention of students through the use of simulation, pointing out that students who use this teaching strategy acquire a more lasting knowledge.<sup>(8,16-18)</sup>

In this context, a study that analyzed the knowledge retention of medical students in the context of cardiopulmonary resuscitation after 42 months of educational intervention, showed that students who had simulation as a teaching strategy retained more knowledge than those who did not.<sup>(16)</sup> In contrast to this study, a survey that assessed knowledge retention through a course of Basic Life Support based on simulation resulted in practical learning and theoretical learning about cardiopulmonary resuscitation, however, the positive retention effect was not maintained after year and five months, except in participants who repeated training in that period, indicating that long-

term content retention requires more training opportunities or practice.<sup>(19)</sup>

Controlled clinical trial that assessed the effectiveness of using simulation in the teaching and learning process in relation to traditional teaching, demonstrated that both groups showed improvement in knowledge; however, students in the experimental group retained more knowledge than those in control.<sup>(20)</sup>

We highlight here the difference in cognitive performance that the use of clinical simulation promotes, presenting potential positive impacts on student learning. It is clear, therefore, the great potential of simulation to deal with problems related to the development of knowledge and competence of professionals, insofar as it overcomes the passive reception process centered on the transmission of content, present in most curricula.<sup>(21)</sup> Through the Miller pyramid, it is identified that when a curriculum is predominantly composed of teaching sequences where the disposition of content predominates, “know how” and “show how” have been neglected, considerably compromising the teaching and learning process of students.<sup>(22)</sup>

Specifically, in terms of the retention of knowledge adopted in this study, through an assessment after 30 days of intervention, the results corroborate those found in the studies discussed earlier, where it remains clear that the simulated experiences contribute to the acquisition of different skills and promote greater use and, consequently, greater retention of knowledge.

It is also reflected on clinical simulation as an effective teaching strategy in the process of vocational training in nursing in Brazil; in the pre-test, a low level of knowledge about the subject of Basic Life Support focused on emergencies in PHC was verified, where both the control and the experimental group obtained a mean of 3.9 points (maximum=10 points).

The authors<sup>(23)</sup> point out that the levels of knowledge of NTs are insufficient with regard to issues inherent to care practice. As a result, the impact of this gap on nursing care is reflected, considering that NTs represent the largest health professional category, thus it is assumed that the assistance of-

ferred by them has a substantial impact on Brazilian health.<sup>(7)</sup>

It is important, at this moment, to reflect on the formation of this category, especially with regard to teaching staff constitution, the teaching methodologies used, the distribution of hours and the curriculum being matched to ministerial regulations.

There is a scientific gap about studies that use students or NTs as a population and their training as an object of study. Just as we can present students' later experiences as simulated practices as limiting factors of this study. However, the results presented in the present research point to a primarily deficient knowledge and that after teaching with the use of clinical simulation, the knowledge levels of these students consubstantially increase not only in a punctual but late manner.

Thus, the study presents results of increased knowledge of studies, which assumes an improvement in the qualification of future professionals through the use of clinical simulation, which, in its structural genesis, presents - when used effectively - contributions that go beyond the classrooms, timely knowledge and summative assessments.

The authors recommend the use of clinical simulation as a teaching strategy to be used in vocational secondary education in nursing, with a view to increasing the levels of knowledge and learning retention. As a study limitation, it is impossible to assess a longer knowledge retention, the use of non-validated knowledge assessment questionnaires among other peers, in addition to the research team, and the reduced sample number as a result of sample loss.

## Conclusion

Students who had the opportunity to learn from the use of clinical simulation methodology, retained better cognitive performance in the long term (30 days) when compared to those who were submitted to a traditional teaching strategy. Additionally, it was evidenced, in the researched context, that younger students, female and between 16 and 25 years old, learn more in comparison to the others.

Thus, the use of clinical simulation in nursing education is encouraged, considering its positive effect on cognitive performance - in the short and long term, which tends to collaborate with aspects that go beyond personal professional training, taking into account account the social impacts of quality, effective and safe health care.

## Acknowledgments

This work was carried out with the support of the Brazilian National Council for Scientific and Technological Development (CNPq - *Conselho Nacional de Desenvolvimento Científico e Tecnológico*) - Brazil - Financing Code 001, by granting a master's scholarship to Marília Souto de Araújo.

## Collaborations

Araújo MS, Medeiros SM, Costa RRO, Coutinho VRD, Mazzo A and Sousa YG contributed to design, writing, relevant critical review of intellectual content and approval of the final version of the article.

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