



Original article

Cohort study to evaluate the assimilation and retention of knowledge after theoretical test in undergraduate health science



Jorge Josaphat Ferreira*, Lukewell Maguta, António Bernardo Chissaca, Inocêncio Fancisco Jussa, Sara Sarajabo Abudo

Faculty of Health Sciences, Lurio University, Nampula, Mozambique

ARTICLE INFO

Article history:

Received 2 August 2016

Accepted 24 October 2016

Available online 17 November 2016

Keywords:

Assimilation capacity

Retention capacity

Theoretical lesson

Undergraduate

Health science

ABSTRACT

Background: Each year new undergraduate courses are emerging in Mozambique, and with them the number of students has been increasing exponentially. In higher education institutions, particularly in the health sciences, knowledge retention becomes essential for learning and for efficient and effective training of capable health professionals.

Methodology: This is a prospective cohort study, conducted at the Lurio University, Mozambique. To evaluate the assimilation and retention of knowledge, a theoretical lesson was taught. The class time was 90 minutes divided into a theoretical stage and the other was a discussion stage (30 minutes) for clarification of doubts. Questionnaire was administered in the pretest, post-test and after six months.

Results: Of all students ($n = 241$), enrolled in the second semester of the first year of the course, 190 students did the pretest, 187 did the post-test and 183 students did the test after six months. Before the lecture none of the course managed to achieve the satisfactory percentage of 75% of correct answers ($p < 0.001$). Assimilation of knowledge in the post-test performance there has been a significant increase in knowledge, in all questions the students reached the recommended percentage as “satisfactory knowledge” ($p < 0.001$). The post-test suggests that participants in this study had a significant capacity of memorization which is essential in the retention of knowledge.

Conclusion: It can be concluded that the assimilative and retention capacity improve the student knowledge immediately after a theoretical lesson with addition audiovisual resources, and the acquired knowledge remains even though there is a deterioration with passage of the time.

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Background

Higher education has been the subject of numerous discussions in Mozambique and worldwide. The development of undergraduates and commitment to general education, which enables the student a basis on which he/she can develop and learn continuously is in “Undergraduate Legislation Reports in Mozambique”. There are two relevant recommendations: the mediating role of the teacher should play in teaching and learning process, and the active of students stance in the construction process of knowledge.¹

The assimilation and retention of knowledge are profound and ongoing activities that are restricted to the context of formal instruction and are essential to maintain good academic

performance of students. In higher education institutions, particularly in the health sciences, knowledge retention becomes essential for learning and for efficient and effective training of capable health professionals.² This type of learning is created through personal development which should be enhanced to promote the transmission of new knowledge, concepts and attitudes in addition to specific technical training of the subject.³

Each year new undergraduate courses are emerging in Mozambique, and with them the number of students has been increasing exponentially. One reason for this increase is justified by demographic and statistical data.⁴ Among 20 million Mozambicans, only 100,000 are students in higher education, which means a gross rate of participation in higher education of only 0.5%, compared to an African mean of 5.4%. This expansion of higher education must be accompanied by continuous improvement of in the quality of the courses that institutions offer. In this sense they should pay particular attention to the fulfillment of quality standards regarding robust and competitive training.⁵

* Corresponding author.

E-mail address: jorgejosap@gmail.com (J.J. Ferreira).

Traditionally the theoretical lesson is the most used ways to promote the assimilation and retention of knowledge in higher education. This method consists of “verbal lecture used by teachers with purpose of transmitting knowledge” about a subject in a logical way. It is the most method used to be more easily suited to numerous classes. Furthermore, a flexible method is, or may be adapted in real time to various audiences, in addition to allowing the use of various audiovisual resources (from traditional slate even the audiovisual resources), for example, use of multimedia projector and programs like PowerPoint and Prezi.⁶ Summarizing its advantages as producing better visual effects, high efficiency in information transfer, precise and systemic knowledge structure. Disadvantages of addition audiovisual may be induced by irrelevant information, neglect of interaction with students, uncontrolled speed in presenting or too strict order of information.⁷

There are various learning styles, methods, techniques, means and teaching procedures as strategies to evaluate the assimilation and retention of knowledge, and cannot be reduced only to theoretical lesson. Although the theoretical lesson was choice of this article because it has been the most used teaching strategies in UniLurio, therefore it is important to mention the use of other strategies, such as supervised study, discussion, seminars, case study, simulation lab, drama, movies, integrative panel, creative games, teamwork, portfolio, online programs and educational workshop.^{8–10}

In this context scientific research is seen as one of the tools that can help in the teaching and learning process because it helps both validation of already established practices and qualifying their use in everyday life, as in the critical transformation of the present, by the opportunity to point out the necessary changes.¹¹ Based on these, the goal is to discuss the assimilation and retention of knowledge among university students of health sciences in UniLurio.

Methodology

This is a prospective cohort study, conducted at the Faculty of Health Sciences, Lurio University (UniLurio) in Nampula, Mozambique, from September 2014 to March 2015. The study included students from undergraduate courses (medical, dentistry, pharmacy, optometry, nutrition and nursing) who were enrolled in the second semester of the first year of 2014 and were willing to participate.

To evaluate the assimilation and retention of knowledge, a theoretical lesson (with multimedia projector and PowerPoint program) was taught in the discipline of Community Health, in September 2014, by an Assistant Professor with a Master of Science degree in Epidemiology. The theme chosen for the lecture was the Ebola Outbreak because in 2014 the World Health Organization (WHO) confirmed the largest epidemic Ebola virus of all time¹² that was responsible for the deaths of many health professionals.¹³ The class time was 90 min divided into a theoretical stage (60 min), based on knowledge of WHO guidelines, and the other was a discussion stage (30 min) for clarification of doubts. The location of the lecture was the Magna Room at the UniLurio. The lecture and data collection was given to all the courses at the first year at the same time.

The research instrument used for data collection was a simple questionnaire (with the contents of the theoretical lesson), encoded by student number, and with 9 closed questions (1. *The name of the course*; 2. *First country to emerge Ebola Virus*; 3. *How to diagnose the disease*; 4. *Do you know the signs and symptoms*; 5. *Do you know how to confirm a sick person with Ebola Virus*; 6. *Do you know how to treat a patient with Ebola Virus*; 7. *Do you know how to prevent the disease*; 8. *Do you know how to do the biosecurity against Ebola Virus*; 9. *Do you know the main difficulties to control the disease*), and 5 open questions on which the students should reference to three symptoms, three interventions, three ways of prevention, three ways

of biosecurity and three ways to difficulties in controlling the disease caused by the Ebola virus according to WHO guidelines. For quantitative analysis of the open questions was considered correct answers those who have at least two right reference.

This questionnaire was administered in three evaluation periods, the first before the lecture (pretest), the second after the lecture/discussion (post-test) and the third six months later (after six months). Some students who did not respond to the questionnaire in all evaluation periods were excluded. Although the research instrument has not established objective parameters of percentage of correct answers, literature data indicates that 75% of success is considered a satisfactory result.¹⁴ Thus, this study considered 75% accuracy as a satisfactory result.

Statistical analysis

An analysis was performed using the Statistical Package for Social Sciences (SPSS) 21.0. Categorical variables were expressed as percentages or absolute values, and continuous values as mean \pm standard deviation. For the inferential analysis of comparison between continuous variables among the three evaluation periods and between courses, an analysis of variance (ANOVA) for parametric data was included and for the comparisons of categorical variables we used the chi-square test, which considered a significant value of $p < 0.05$.

Ethical approval

This study was approved by the Institutional Ethics Committees of UniLurio, reserving all rights of the participants and the institution, ensuring participants the freedom to refuse to participate or withdraw consent during the investigation.

Results

Sample characterization

Of all students ($n = 241$), enrolled in the second semester of the first year of the course, 190 students did the pretest, 187 did the post-test and 183 students did the test after six months. Among medical students ($n = 60$), 46 answered the pretest, 50 post-test and 37 after six months. Of all dentistry students ($n = 30$), 28 participated in the pretest, 20 post-test and 26 after six months. In relation to pharmacy students ($n = 30$), 17 responded to the pretest, 17 post-test and 20 after six months. Among the optometry students ($n = 30$), 14 answered the pretest, 18 post-test and 21 after six months. For nutrition students ($n = 61$), 49 participated in the pretest, 53 post-test and 51 after six months. As for the total nursing students ($n = 36$), 36 responded to the pretest, 29 post-test and 28 after six months. 43 students were excluded from the study because they did not answer to the questionnaire in all evaluation periods, (13 medical, 8 dentistry, 3 pharmacy, 4 nutrition, 7 optometry and 8 nursing). Thus, a total of 165 students answered the questionnaire in the three evaluation periods and so were eligible for the study (37 medical, 20 dentistry, 17 pharmacy, 49 nutrition, 14 optometry and 28 nursing).

Frequency of correct answers

All questions showed differences in the frequency of correct answers in the pretest, post-test and after six months of lecture. In all questions, the frequency of correct answers of the pretest demonstrates that students had little knowledge about the Ebola virus, for example in the question “*Write two biosafety interventions against Ebola Virus*” among 165 students were only 38% able

Table 1

Frequency of correct answers of all students in the theoretical test applied in the pretest, post-test and after six months of the theoretical lesson about the Ebola virus. Nampula, September 2014 to March 2015.

Asked questions on ebola virus disease	Frequency of correct answers			
	Pretest n = 165 (%)	Post-test n = 165 (%)	After six months n = 165 (%)	* p
Where did the Ebola Virus Disease emerge	43 (26%)	141 (86%)	104 (63%)	<0.001
How do you diagnose Ebola Virus Disease	76 (46%)	161 (98%)	142 (86%)	<0.001
Write two signs or symptoms of the Ebola Virus Disease	108 (66%)	161 (98%)	157 (95%)	<0.001
How do you confirm the diagnosis of the Disease	34 (21%)	149 (90%)	116 (70%)	<0.001
Write two interventions during treatment	13 (8%)	101 (61%)	59 (36%)	<0.001
Write two biosafety interventions against Ebola Virus	62 (38%)	144 (87%)	116 (70%)	<0.001
Write two interventions to prevent Ebola Disease	64 (39%)	147 (89%)	103 (62%)	<0.001
Write two difficulties to control the Ebola Disease	35 (21%)	116 (70%)	70 (42%)	<0.001

* Pearson's chi-square test. Data presented with n (%).

to answer correctly (Table 1). In all questions the frequency of correct answers of the post-test was significantly better compared to the pretest, for example in the question "Write two interventions to prevent Ebola Disease" among 165 students only 39% from pretest were able to answer correctly and from post-test shows a significant increase, 89% were able to answer correctly in accordance with $p < 0.001$ (Table 1). The frequency of correct answers after six months shows that the retention of knowledge of students suffered a significant decrease, for example in the question "Write two difficulties to control the Ebola Disease" among 165 students 21% from pretest and 70% from post-test were able to answer correctly, but after six months suffered a significant decrease only 42% were able to answer correctly in accordance with $p < 0.001$ (Table 1).

Considering the expected performance of 75% of correct answers in the theoretical test for students of all courses, the results show that during the pretest no course has achieved this percentage. After the lecture all the courses have achieved the 75%, with the nursing group achieving (92.4%) and medicine course (88.2%). After six months the performance decreased in all courses mainly in medicine (65.9%) nursing (65.6%) and nutrition (65.1%). Comparing students for performance in the theoretical test, it was found that there was a significant difference in the frequency of correct answers in all courses in the pretest, post-test and in six months later. The performance of students after the lecture (post-test) shows that the assimilation capacity of knowledge in all courses was considerably high. After six months to evaluate the retention capacity and the results show a significant reduction of the number of correct answers in all courses compared to the post-test and no course has been able to achieve 75% of correct answers. The data is shown in Table 2.

Mean of correct answers

Concerning the correct answers of students of all courses, the mean in the pretest was 4.6 (± 0.7), post-test 11.9 (± 0.3), and

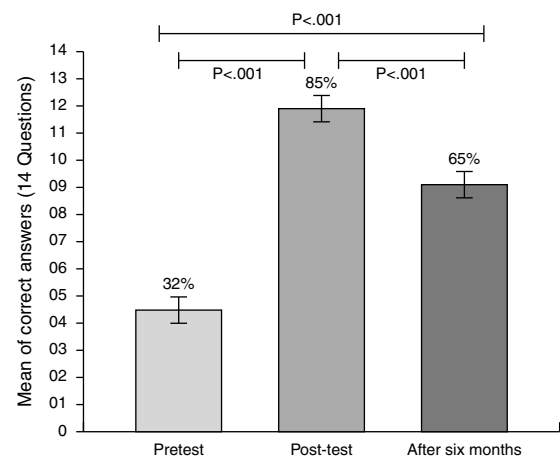


Fig. 1. Mean of correct answers of students of all courses in the pretest, post-test and after six months (ANOVA).

six months later it was 9.2 (± 0.4) out of, a total of 14 points ($p < 0.001$). This difference was significant between the pretest, post-test and after six months ($p < 0.001$). The data is shown in Fig. 1.

About the numbers of correct answers in the pretest between the students of each course, the difference of the mean of correct responses was statistically significant. The mean of correct answers of the dentistry students 6.9 (± 0.8) was higher and optometry students 2.9 (± 0.8) was lowest compared to the other courses, in the total of 14 points ($p < 0.001$). In the post-test the difference of the mean of correct responses was also statistically significant, nursing students 12.9 (± 0.3) and medicine students 12.3 (± 0.4) was higher and dentistry students 10.6 (± 0.6) was lowest compared to the other courses, out of a total of 14 points ($p < 0.001$). After six months there was no statistically significant difference between the students of each course, according to the data shown in Fig. 2.

Discussion

Knowledge about the Ebola virus is an important goal especially for professionals and students of health in Mozambique, considering that the epidemic is a phenomenon that occurs primarily in African countries.^{12,13} This research confirmed that there was a significant lack of knowledge about the Ebola virus among health sciences students from UniLurio. Before the lecture none of the course managed to achieve the satisfactory percentage¹⁴ of 75% of correct answers ($p < 0.001$). Another studies^{15–17} have shown similar results, there is a low level of knowledge about the Ebola virus in African countries, even though they are the most affected by the disease.

Table 2

Frequency of all correct answers in the theoretical test of all students and for each course to pretest, post-test and after six months about the Ebola Virus Disease. Nampula, September 2014 to March 2015.

Courses	Total correct answers			* p
	Pretest n (%)	Post-test n (%)	After six months n (%)	
Medical	100 (34%)	261 (88%)	195 (66%)	<0.001
Dentistry	78 (49%)	122 (76%)	111 (69%)	<0.001
Pharmacy	38 (28%)	106 (78%)	91 (67%)	<0.001
Optometry	23 (21%)	89 (80%)	68 (61%)	<0.001
Nutrition	119 (30%)	335 (86%)	255 (65%)	<0.001
Nursing	77 (34%)	207 (92%)	147 (66%)	<0.001

* Pearson's chi-square test. Data presented with n (%).

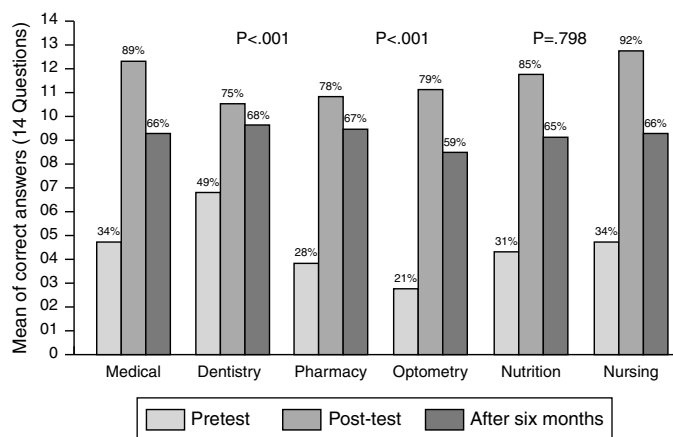


Fig. 2. Mean of correct answers of students for each course in the pretest, post-test and after six months (ANOVA).

To promote the assimilation of knowledge, two studies suggest that the use of active methods are necessary. One study¹⁸ mentioned the importance of out-indulgence and mobilization, with individual and collective changes, so that the teacher may become a facilitator, with communication and observation skills, realizing the different moments of learning. Another study¹⁹ corroborated that teachers need to innovate in teaching strategy and assessment so that learning makes sense and can last for a lifetime. The most used active methods to promote the assimilation of knowledge is the theoretical lesson with addition audiovisual resources. This methods is now widely used in lectures to science students in most universities of world.²⁰ Its advantages as producing better visual effects, high efficiency in information transfer, precise and systemic knowledge structure necessary to promote the assimilation of knowledge.⁷

This context may explain why in UniLurio, after theoretical lesson with addition audiovisual, the health sciences students showed high levels of assimilation of knowledge in the post-test performance. During this period there has been a significant increase in knowledge because in all questions the students reached the recommended percentage as “satisfactory knowledge” ($p < 0.001$). This result provides evidence that matched the studies done outside Africa^{21,22} which found a significant increase in knowledge after applying the post-test among students of health sciences.

Memory is characterized by storing and recovery of past events and it is closely linked to attention, perception and information processing systems.^{23,24} Accordingly, the post-test suggests that participants in this study had a significant capacity of memorization which is essential in the retention of knowledge. Nevertheless, in adults the short-term memory is a system in which knowledge is rapidly lost in the absence of information maintenance, which can lead to a possible forgetting.²⁵ In this study the assessment after six months, there was a significant reduction in the frequency of the numbers of correct answers of all students ($p < 0.001$). The range of six months may have decreased student performance interfering in perceptual mechanisms and levels of attention and thus caused a deficit in knowledge retention, resulting in loss of information in all courses. This result confirms the explanations of other studies^{26–28} conducted in the United States, where it was observed that knowledge retention is reduced over the long term.

The main result of this research was the large capacity of assimilation of knowledge among students after the lecture, according to the mean of correct answers in the pretest (4.6) compared to the post-test (11.9), however with the passage of time, if the knowledge was lost (9.2) from a total of 14 points ($p < 0.001$), even then, it suggests a positive assimilation and retention of knowledge among all

students. These results support data in the literature that show similar results. A study in England²⁹ evaluated the knowledge of health professionals, after three hours of update, it found initial improvement, with significant reduction of knowledge in 10 weeks. Another study,³⁰ evaluated the assimilation and retention of knowledge among nursing students, the results found better assimilation after training, but significant reduction in two and a half months later. Although an evaluation of only the theoretical knowledge of students was done, the findings here will meet these studies and others found that the knowledge acquired reduces over time.³¹

Another important result is the pre-test because there was a significant difference between the mean of correct answers. The course had the most knowledge about the Ebola virus was the course of dentistry with the highest mean of correct answers (6.9) of the total of 14 points ($p < 0.001$). In the post-test it was observed that the nursing (12.9), medicine (12.3) and nutritional (11.9), of the total 14 points ($p < 0.001$), had a greater ability to assimilate knowledge because they present a higher mean of correct answers compared with other courses. After six months the mean of correct answers of all courses decreased, however there was no statistically significant difference between courses. This result suggests that students have the same retention level of knowledge. While accessing the literature,^{26,32,33} we noticed that studies like this have been conducted worldwide, and our results are similar to those in these studies. The retention levels in the adult population are universally low, 50–60% approximately, regardless of the nature of the skills or material being taught, regardless of the age or background of the learner, forgetting happens. Teachers rightfully focus their efforts on helping students acquire new knowledge and skills, but newly acquired information is vulnerable and easily slips away. Even highly motivated learners are not immune: Medical students forget roughly 25–35% of basic science knowledge after 1 year, more than 50% by the next year.^{34,35}

Some studies^{36,37} have reported that the ways to promote the assimilation and retention of knowledge two conditions are required: first, the student willingness to learn. If student only wants to store content, learning will be mechanical, with no incorporation of knowledge to what student already knows. Second, the presented content has to be logical and meaningful. Thus, each student make an assimilation and retention of the content that considers meaningful or not. In this sense, students has to be willing to learn and the role of a teacher is to select potentially significant materials, that is, that make sense to the student with linking potential with previous knowledge. The teacher has to touch the existing structure of the learner, awaken the students for the incorporation of new ideas, with transformation and refinement of what was already known.³⁸ From this study, it can be concluded that the assimilative and retention capacity improve the student knowledge immediately after a theoretical lesson with addition audiovisual resources, and the acquired knowledge remains even though there is a deterioration with passage of the time.

It is important to note that assimilation and retention of knowledge was evaluated only through a simple questionnaire independently of race, gender, age, socio-economic and cultural levels. The disciplines that were taught in the first semester does not contain the theme chosen for the lecture (Ebola Outbreak), and that is why not helped to contribute to a better understanding of the theoretical lesson. And also the learning styles of the participants were not assessed. Therefore this deterioration is more noticeable by using valuation methods involving performance and sociodemographic data. Another valuations can be employed in using interviews or focus groups in order to identify external factors that can benefit the research purpose and might help to better understand the obtained results.

Finally the literature have a lot of suggestion to improve the assimilation and retention of knowledge, various studies^{39–41} agree

that is necessary to encourage students to summarize what they have learned, to create a series of questions at the end of the activity to help them boost their knowledge retention, to assess the knowledge of students after lesson and repeat information using different formats.

Conflicts of interest

The authors declare no conflicts of interest.

References

- Colectânea de Legislação do Ensino Superior, Direção para a Coordenação do Ensino Superior. Ministério da Educação. República de Moçambique. Edição Revista. Maputo [Internet]; 2012. Available from: www.mined.gov.mz/DN/DICE/Documents/Colectanea [accessed 10.02.15].
- Battisti P. Retenção do Conhecimento na EaD [dissertação]: O Estudo de Caso do Programa de Capacitação em Rede: Competências para o Ciclo de Desenvolvimento de Inovações – Projeto e-Nova/Florianópolis, SC; 2012, 131 p.; 21cm. Dissertação (mestrado) – Universidade Federal de Santa Catarina, Centro Tecnológico. Programa de Pós-Graduação em Engenharia e Gestão do Conhecimento.
- Anastasiou L, Alves LP. Processos de Ensino na Universidade. Joinville: Ed. Univile; 2003.
- Rodrigues MAF, e Cassy B. A Gestão Acadêmica como determinante da Qualidade de Ensino; 2013. Available in: <http://www.forumgestaoensinosuperior2011.ul.pt/docs/documentos/15/painéis/09/mafr.bc.pdf> [accessed 12.04.15].
- Freire P. Educação e mudança. Rio de Janeiro: Paz e Terra; 2001.
- GiL, Carlos A. Didática do Ensino Superior. São Paulo: Atlas; 2009. p. 133/4.
- Ding Xingeng D, Jianxiang L. Advantages and disadvantages of PowerPoint in lectures to science students. Int J Educ Manag Eng. 2012;9:61–5. <http://dx.doi.org/10.5815/ijeme.2012.09.10>. Published Online September 2012 in MECS (<http://www.mecs-press.net>).
- Kenski VM. Processo de interação e comunicação no ensino mediado pelas tecnologias. In: Rosa DEG, Souza VC, Feldman D, et al. (org.). Didáticas e práticas de ensino: interfaces com diferentes saberes e lugares formativos. Rio de Janeiro: DP&A, 2002, p. 254–64.
- Paça, de Almeida JL, Scarinci AL. O que pensam os professores sobre a função da aula expositiva para a aprendizagem significativa. Ciência Educ (Bauru). 2010;16:709–21. <http://dx.doi.org/10.1590/S1516-731320100003000014>.
- Waterkemper R, do Prado ML. Teaching-learning strategies in undergraduate Nursing courses. Adv Enferm. 2011;29:234–46. Available from: <http://www.scielo.org.co/scielo.php?script=sci.arttext&pid=S0121-4500201100200003&lng=en&tng=pt> [Internet] 2016, October.
- Castilho V. Educação continuada em enfermagem: a pesquisa como possibilidade de desenvolvimento de pessoal. Mundo Saúde. 2000;24:357–60.
- Centers for Disease Control and Prevention Outbreaks Chronology: Ebola Virus Disease [Internet], August; 2014. Available from: <http://www.cdc.gov/vhf/ebola/outbreaks/history/chronology.html>
- Current Situation. Cases in the most affected countries. World Health Organization, WHO; 2014. Ebola virus disease [Internet]. Available from: <http://apps.who.int/ebola/>
- Semeraro F, Signore L, Cerchiari EL. Retention of CPR performance in anaesthetists. Resuscitation. 2006;68:101–8.
- Highsmith HY, Cruz AT, Guffey D, Minard CG, Starke JR. Ebola knowledge and attitudes among pediatric providers before the first diagnosed case in the United States. Pediatr Infect Dis J. 2015. PubMed PMID: 26020407 [Epub ahead of print].
- Rübsamen N, Castell S, Horn J, Karch A, Ott JJ, Raupach-Rosin H, et al. Ebola risk perception in Germany, 2014. Emerg Infect Dis. 2015;21:1012–8. <http://dx.doi.org/10.3201/eid2106.150013>. PubMed PMID: 25989020.
- Judson S, Prescott J, Munster V. Understanding ebola virus transmission. Viruses. 2015;7:511–21. <http://dx.doi.org/10.3390/v7020511>. PubMed PMID: 25654239; PubMed Central PMCID: PMC4353901.
- Kalinowski CE, Massoquetti RMD, Peres AM, Larocca LM, Cunha ICKO, Gonçalves LS, et al. Participative methods in teaching administration within nursing. Interface Co-mun Saúde Educação [Internet]. 2016;17:259–67. Available from: <http://www.scielo.br/pdf/icse/v17n47/aop4413.pdf> [Portuguese].
- Price J, Dornan J, Quail L. Seeing is believing – reducing misconceptions about children’s hospice care through effective teaching with undergraduate nursing students. Nurse Educ Pract [Internet]. 2016;13:361–5. Available from: <http://www.sciencedirect.com/science/article/pii/S1471595312001734>
- Daniels L. Introducing technology in the classroom: PowerPoint as a first step. J Comput High Educ. 1999;10:42–56.
- Ribeiro LG, Germano R, Menezes PL, Schmidt A, Pazin-Filho A. Estudantes de medicina ensinam ressuscitação cardiopulmonar a alunos do fundamental. Arq Bras Cardiol [Internet]. 2016. <http://dx.doi.org/10.5935/abc.20130165>. Available from: <http://www.scielo.br/scielo.php?script=sci.arttext&pid=S0066-782X2013003000007&lng=en> [Epub August 14, 2013].
- da Costa Brião R, de Souza EN, de Castro RA, Rabelo ER. Estudo de coorte para avaliar o desempenho da equipe de enfermagem em teste teórico, após treinamento em parada cardiorrespiratória. Rev Latino-m Enferm [Internet]. 2016. <http://dx.doi.org/10.1590/S010411692009000100007>. Available from: <http://www.scielo.br/scielo.php?script=sci.arttext&pid=S0104-11692009000100007&lng=en>
- CRAIK. FIM human memory. Annu Rev Psychol [Palo Alto]. 1979;30:63–102.
- Norman DA. Toward a theory of memory and attention. Psychol Rev. [Pittsburgh]. 1968;6:522–36.
- Marteniuk RG. Information processing, channel capacity, learning stages and the acquisition of motor skill. In: Whiting HTA, editor. Readings in human performance. London: Lepus; 1975. p. 5–33.
- Atkinson RC, Shiffrin RM. The control short-term memory, vol. 2. New York: Scientific American; 1971. p. 82–90.
- Breckwoldt J, Beetz D, Schnitzer L, Waskow C, Arntz HR, Weimann J. Medical students teaching basic life support to school children as a required element of medical education: a randomised controlled study comparing three different approaches to fifth year medical training in emergency medicine. Resuscitation. 2007;74:158–65.
- Einspruch EL, Lynch B, Aufderheide TP, Nichol G, Becker L. Retention of CPR skills learned in a traditional AHA Heart Saver course versus 30-min video self-training: a controlled randomized study. Resuscitation. 2007;74:476–86.
- Broomfield R. A quasi-experimental research to investigate the retention of basic cardiopulmonary resuscitation skills and knowledge by qualified nurses following a course in professional development. J Adv Nurs. 1996;23:1016–23.
- Madden C. Undergraduate nursing students acquisition and retention of CPR knowledge and skills. Nurs Educ Today. 2006;26:218–27.
- Hollis S, Gillespie N. An audit of basic life support skills amongst general practitioner principals: is there a need for regular training? Resuscitation. 2000;44:171–5.
- Chamberlain D, Smith A, Woollard M, Colquhoun M, Handley AJ, Leaves S, et al. Trials of teaching methods in basic life support (3): comparison of simulated CPR performance after first training and at 6 months, with a note on the value of re-training. Resuscitation. 2002;53:179–87.
- Anderson GS, Gaetz M, Masse J. First aid skill retention of first responders within the workplace. Scand J Trauma Resusc Emerg Med. 2011;19:11.
- Custers E. Long-term retention of basic science knowledge: a review study. Adv Health Sci Educ: Theory Pract. 2010;15:109–28.
- Custers E, ten Cate O. Very long-term retention of basic science knowledge in doctors after graduation. Med Educ. 2011;45:422–30.
- Moreira MA. Aprendizagem significativa: a teoria e textos complementares. São Paulo (SP): Editora Livraria da Física; 2011.
- Pelizzari A, Kriegl ML, Baron MP, Finck NTL, Dorocinski SI. Teoria da aprendizagem significativa segundo Ausubel. Rev PEC [Internet]. 2002;2:37–42. Available from: <http://portal.dopositor.mec.gov.br/storage/materiais/0000012381.pdf> [cited 20.08.14].
- Lino A, Fusinato PA. The influence of prior knowledge in the teaching of Modern and Contemporary Physics: an account of conceptual change as a process of meaningful learning. Rev Bras Ensino Ciência Tecnol [Internet]. 2016;4:73–100. Available from: <https://periodicos.ufr.edu.br/rbect/article/view/1050/735> [Portuguese].
- Lindsey RV, Shroyer JD, Pashler H, Mozer MC. Improving students’ long-term knowledge retention through personalized review. Psychol Sci. 2014;25:639–47. <http://dx.doi.org/10.1177/0956797613504302>. PMID: 24444515 [Epub 2014 January 20].
- Atkinson RC. Optimizing the learning of a second language vocabulary. J Exp Psychol. 1972;96:124–9.
- Bjork R. Memory and metamemory considerations in the training of human beings. In: Metcalfe J, Shimamura A, editors. Metacognition: knowing about knowing. Cambridge, MA: MIT Press; 1994. p. 185–205.