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Self-learning through the *PhysioEx™ 9.0* simulator as a teaching tool in Veterinary Physiology. The opinion of the students

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Abstract

Self-learning has been proposed as an active and plausible methodology to promote the capability of students to reach assigned objectives. During the academic year of 2016-2017, the course of Veterinary Physiology (included in the degree of Veterinary Medicine, University of Murcia, Murcia, Spain) was given using a self-learning method through the computer simulator PhysioEx™ 9.0. The practice consisted in solving 6 exercises, performing simulated laboratory actions, knowing the consequences of each of their actions and answering a series of questions that were discussed afterwards with their classmates. The objective of this learning methodology was to teach students to work independently as well as a team member, promoting their skills to solve problems that might appear later in their professional life. After the practice, the students completed a voluntary survey whose results showed a satisfying opinion about using this self-learning methodology, reaching an average score on the proposed statements (a total of 7) between 4.01 and 4.71 on a Likert scale from 1 to 5. Additionally, the students associated the practice with concepts as 'classmates', 'doubts', 'dynamic', 'better', 'help' and 'knowledge'. In conclusion, this activity increased the collaborative learning process of students and enhanced dynamism in class.

Keywords: *autonomous; collaborative; computer; dynamic; practice; teaching methodology.*

1. Introduction

The learning process is a complex play with two main characters: the teacher and the student. The role of the teacher should not be to recite his/her knowledge but instead it should be to show the student how to acquire it (Lujan & DiCarlo, 2006). It is known that learning does not consist of memorizing a set of data but to gain the ability to solve problems by using resources to search, assess and apply that data. It is clear that the active – not the passive – way of processing of information is the best way to prepare students to face their future professional career (Lujan & DiCarlo, 2006). Self-learning may be one of the possible strategies that promotes the capability of the student to enhance a deep understanding of concepts, naturally achieving the assigned objectives.

In Higher Education, especially in Biomedical Sciences, there is a wide variety of teaching methodologies, such as master classes, seminars, tutorials, directed work and laboratory practices (reviewed by García-Vázquez *et al.*, 2018). In some subjects, such as Veterinary Physiology, it is necessary to complement the theoretical lessons with practical sessions and many of them require the use of animals *in vivo* as a working tool. European society does not accept the indiscriminate and/or unjustified use of animals and the legislation limits the use of laboratory animals to teaching and for research purposes (Directive 2010/63/EU of the European Parliament and of the Council of the 22 September 2010 on the protection of animals used for scientific purposes, OJ L 276, 20.10.2010, p. 33-79). Some of these practical sessions have a high cost, involving a high number of animals or requiring previous experience in animal handling and, consenquently, problems in terms of security. The use of computer simulators is increasing in pursuance of replacing or reducing the use of animals *in vivo*, organic materials, reagents, etc. (Rawson & Quinlan, 2002; Ruiz *et al.*, 2009; García-Vázquez *et al.*, 2011). Simulation is defined by Society for Simulation in Healthcare as 'the imitation or representation of an action or a system through another' and it has become a routine use in Health Sciences's education at all levels. It offers the students the possibility of self-learning and acquisition, training and improvement of competences in a set of tasks of practical situations. All of these advantages without the risk of harming animals or themselves and at an affordable cost (Gulluoglu & Tingoy, 2009). As so, simulators have been considered in education as an effective and economic strategy (McGaghie *et al.*, 2011). This type of self-learning method can be used as a motivating tool for students, providing them, obviously not without effort, the development of critical thinking, communication and problem solving. The self-learning through simulators in which they have to understand and solve situations in a collaborative way with their peers improves the training of good professional skills to face future situations.

The use of this interactive pedagogical tool promotes the awareness of the contents of Veterinary Physiology, simulating situations that in their day-to-day work would require immediate action, providing them the chance to observe, think and then react - without

having the negative consequences for their actions. However, this type of tools can have disadvantages such as the lack of manipulation of equipment, animals or living samples, which could turn the student into a mere observer in a real situation. Thus, the objective of this study was to promote collaborative self-learning among students of Veterinary Physiology through *PhysioEx™ 9.0* simulator and assess the advantages and disadvantages that students find in this methodology of learning.

2. Material and Methods

To implement self-learning among the students of Veterinary Physiology (Veterinary degree) practices with the *PhysioEx™ 9.0* simulator (García-Vázquez *et al.*, 2011) were carried out during the 2016-2017 academic course by using the computer classroom of the Faculty of Veterinary Medicine in groups of 18-20 students. Every 2-3 students shared a computer to carry out the practice collaboratively and discuss the results between them.

PhysioEx™ 9.0 software consists of 13 modules containing a total of 40 physiology laboratory simulations that can be used to complement and/or replace laboratory practices. The use of *PhysioEx™ 9.0* in the practices of the thematic blocks of Respiratory and Renal Systems allowed to complement the theoretical and practical contents previously taught in Physiology. In this type of self-learning sessions the students were autonomous: they could distribute the time dedicated to each exercise as their wish, as well as the repetitions they would perform to each question until total comprehension was achieved. In addition, the software is developed in English, which allows non-native English speakers students to practice and learn the specific terminology in that language.

The practice of self-learning object of study was 3 hours long and consisted of 6 exercises with *PhysioEx™ 9.0* software about the Renal System (previously explained in theoretical sessions). To aid in the progress of the practice and its understanding, the students were provided with a detailed protocol consisting of an introduction on the aspects to deal with, the basic concepts that would be handled and how to perform each exercise step by step. Moreover, they were provided with different books of Physiology to search for information in the case of appearing doubts during the practice. During the development of each exercise, the student had to perform the simulated laboratory actions and understand the consequences of each of their actions. At the end of each exercise and in order to followthrough, the students had to answer a series of questions about the exercise. After the questionnaire, they were told the results of their answers: the ones that were correct and in case of being incorrect, what the correct answer was. After each activity, and to prevent students from keeping any doubt, the results obtained were discussed and shared between all the students under professor supervision. Finally, the students were individually evaluated about the comprehension of the subject by performing a test through an

interactive evaluation system: either through the use of voting controls (*TurningPoint*®) or through mobile devices (*Kahoot*!).

In order to obtain the opinion of the students after the practice, a voluntary survey composed by 7 statements (Q1 to Q7) about self-learning teaching methodoloy was carried out (Table 1). The students had to classify numerically to each sentence, taking into account a Likert scale of 1 to 5, being 1 'strongly disagree' and 5 'strongly agreeing'. In the final part of the survey students were given the opportunity (optional) to highlight up to 3 positive and 3 negative aspects about this self-learning methodology in Veterinary Physiology. Free text comments were automatically categorized (IBM SPSS Text Analytics for Surveys, v.4.0.1.1) based on word repetitions by the students. For the creation of the survey, the application from the University of Murcia was used through the website www.encuestas.um.es.

Table 1. Model of voluntary opinion survey on the self-learning practices using *PhysioEx™ 9.0* completed by the students.

	Score (Likert scale 1-5)
Q1. I consider appropriate the implementation of self-learning practices in the subject Veterinary Physiology I.	
Q2. I think that self-learning practices is an adequate teaching methodology.	
Q3. I consider that this type of methodology helps each student to follow their own rhythm of learning.	
Q4. Performing the exercises during practice together with other colleagues helps to better understand the contents.	
Q5. I consider the dynamics of this practice adequate through the teaching methodology used.	
Q6. I believe the use of gamification (games in teaching) at the end of the practice to strengthen concepts during this type of methodology (self-learning) is appropriate.	
Q7. Global results. Values the set of the implementation of self-learning practices in the subject Veterinary Physiology I.	
Comments: Please indicate up to 3 positive and 3 negative aspects of this teaching methodology.	

3. Results

Of the 124 students enrolled in Veterinary Physiology during 2016-2017, 67.74% attended the practice (84 students) and 79.76% of them completed the voluntary survey (67 students). All students valued the 7 statements with a high degree of satisfaction, reaching a mean score of and above 4.01 on the Likert scale in all questions. Q4 and Q6 were the

statements with highest score (Q1: 4.04; Q2: 4.04; Q3: 4.09; Q4: 4.64; Q5: 4.01; Q6: 4.71; Q7: 4.19) (Figure 1).

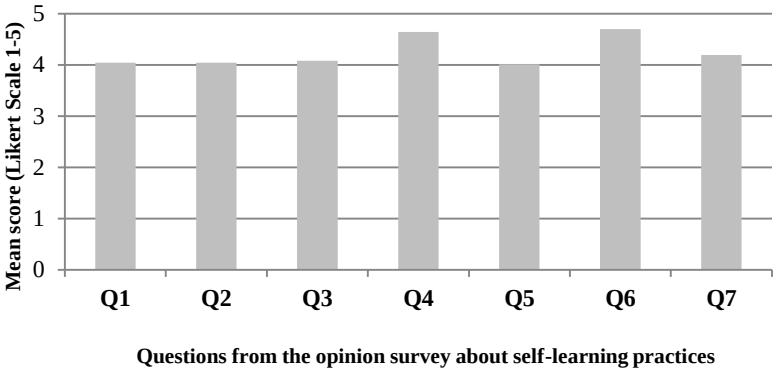
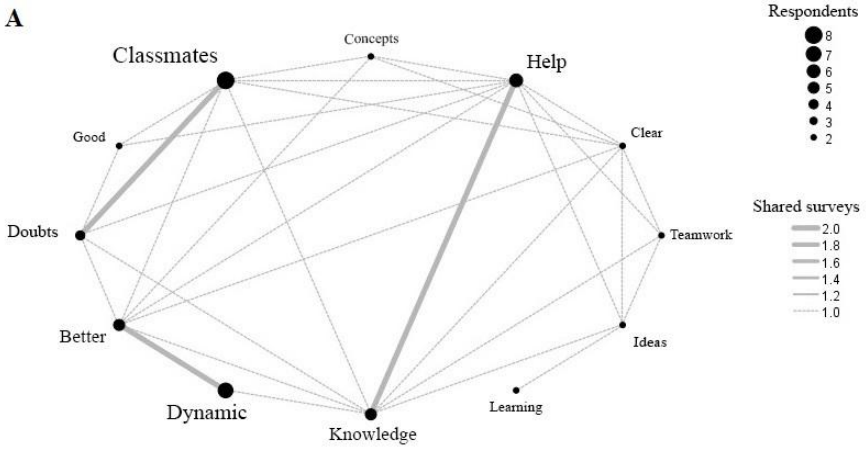


Figure 1. Results obtained from the students on the voluntary opinion survey related to the practice of self-learning using PhysioEx™ 9.0.

A 53.74% of the survey respondents (n=37) also indicated at least one positive aspect of self-learning practice, such as: 'You can test your knowledge and share it with your classmates', 'It is a more dynamic practice', 'It allows the interaction and collaboration with classmates', 'Classmates can help you and we can solve our doubts together', 'It improves learning' and 'It helps us think'. Positive comments were grouped in 12 categories with at least 2 equal answers (Figure 2A). All positive comments were closely related, especially concepts as 'classmates', 'doubts', 'dynamic', 'better' and others as 'help' and 'knowledge'. The 46.26% of the survey respondents (n=31) also indicated some negative aspects, such as: 'The practice is too long' and 'Sometimes the practice becomes a bit tedious', 'Not all students follow the same pace of work', 'We have to wait until all the classmates finish the exercise to discuss about it', 'The language of the software is in English'. Negative comments were grouped in 4 categories with at least 2 equal answers (Figure 2B). Negative comments were closely related, especially concepts as 'tedious' and 'long'.



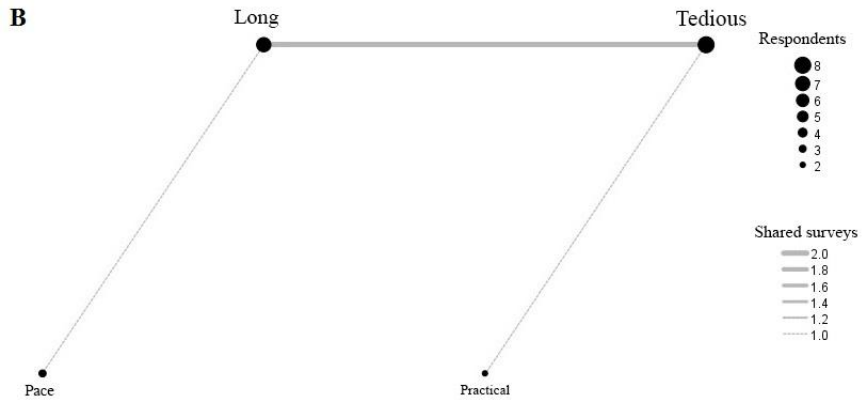


Figure 2. Qualitative analysis of the comments obtained in the voluntary survey made by the students about the self-learning practice with PhysioEx™ 9.0. Number of survey respondents (black circles) and frequency of shared surveys (grey lines) of positive (A) and negative (B) comments.

4. Discusion

The globalization that Higher Education has undergone in recent years has lead to a change in traditional teaching methods. The need to implement new active strategies of learning as a motivating element for students has been incorporated into the teaching process. Nowadays the student has become the main axis of his/her learning. The possibility of improvement, self-evaluation, discussion of concepts with the classmates and reflection on their own learning process and results are postulated as powerful learning strategy. During the development of self-learning, the use of simulators can incorporate special teaching and learning mechanism to support individual learners and satisfy their particular necessity of learning. The possibility of quickly knowing the answers and consequences of each action can improve the understanding of complex physiological systems. In this work we have combined the self-learning in a collaborative way with the use of a computer software that simulates real physiology situations.

The use of simulators as an educational tool is becoming noteworthy in Health Sciences teaching and it presents a high acceptance among students and professors (Abraham *et al.*, 2018; Grupta *et al.*, 2018; Sawatsky *et al.*, 2017). Universities and other institutions have incorporated this kind of self-learning and teaching tools to help training health care professionals. However, the effect of the simulators as a valuable tool still needs to be confirmed. In our case, we implemented a new collaborative self-learning methodology in which a computer simulator was used as a working tool in Veterinary Physiology. In

general terms, the students highly appreciated the self-learning methodology through simulator *PhysioEx™ 9.0* to complement their theoretical and practical sessions.

From the voluntary opinion survey of the students, a positive relationship between different aspect can be deduced. This practical session in which self-learning was encouraged and the students discussed their doubts with their classmates, seemed dynamic and more effective (probably) than other methodologies of learning, in helping them to acquire knowledge. However, it can be also deduced that the main negative factor that could go against self-learning is that the duration and effort that students have to make in this kind of practical sessions seems excessive to them. These results are comparable with previous studies in which the use of animated models were considered useful and effective tools for teaching, allowing students to preserve virtual images that helped them remember the studied mechanisms (García-Vázquez *et al.*, 2011; Gookin *et al.*, 2010; Wang, 2001). Simulators allow to understand dynamic and complex systems whose understanding would be hindered when using static graphics or texts (O'Day, 2007). Performing self-learning practical sessions help them to think for themselves and solve problems/doubts about the physiological system. The results of the satisfaction voluntary survey showed that the dynamic and immersive system of *PhysioEx™ 9.0* improves the comprehension by the students. In general, students consider that self-learning activities help them to understand and remember the contents of the subject. However, they tend to state that the tasks of self-learning are tedious and calls for a lot of time. Although it is understandable that the use of the simulator requires a greater effort by the students to understand and simultaneously integrate the concepts of physiology, it is used within the hours of practices previously established in the teaching program. Another difficulty that students have expressed is the language. It is understandable that the task would be easier if the material was available in their mother tongue, but the reality is that in science most of the available communications are in English, being necessary for student to become familiar with this language.

With this study, we can conclude that self-learning in a collaborative way through the use of computer simulators as *PhysioEx™ 9.0* in Veterinary Physiology favored the learning ability of students. It is an adequate tool for teaching purposes, being in general well appreciated by the students. Moreover, this kind of simulator helps the students to achieve the objectives of the subject with a viable (and sometimes the only possible) alternative to the use of animals in the laboratory. They share and discuss their acquired knowledge with their peers, which can increase the dynamism of the learning process. However, continous improvement of this tool of self-learning is necessary in order to not let it be tedious for students.

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