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Development of alternative activities to animal use in pharmacology education

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Abstract: The aim of this work was to implement three alternative methodologies to replace the animal's use in teaching as an aid tool to the learning/teaching process in pharmacology classes. We proposed to students in Pharmacology classes of Pharmacy course, three technical didactic alternatives to animal use: discussion group on a social network, mental maps and public space for exposure of contents called "Pharmaco window". At the end of the course, we applied a simple questionnaire to students enrolled in the course seeking to evaluate the perception of the understanding, use and acceptance of these three methods. The 26 students (100%) participated in all activities and said that the strategies adopted were positive regarding learning and discussions. They have considered the concept maps as a technique which facilitated the learning process (54%) and the closed group on the social network as the activity that led to a better discussion and understanding of the contents (77%). All the techniques adopted contributed positively. Thus, the didactic alternatives to use of animals in classes made possible the transmitting of knowledge, saving the even a small number of animals to suffer and following ethical values.
Keywords: Alternative Methods; Pharmacology; teaching and learning.

Desenvolvimento de atividades alternativas para o uso de animais no ensino de farmacologia
Resumo: O objetivo deste trabalho foi implementar três metodologias alternativas para substituir o uso de animais no ensino como ferramenta de auxílio ao processo de ensino/aprendizagem nas aulas de farmacologia. Propusemos aos alunos das aulas de Farmacologia do curso de Farmácia, três técnicas alternativas didáticas ao uso de animais: grupo de discussão em uma rede social, mapas mentais e espaço

público para exposição de conteúdos denominados "Janela da Farmaco". Ao final do curso, aplicamos um questionário simples aos alunos matriculados no curso, buscando avaliar a percepção do entendimento, uso e aceitação desses três métodos. Os 26 alunos (100%) participaram de todas as atividades e afirmaram que as estratégias adotadas foram positivas em relação ao aprendizado e discussões. Eles consideraram os mapas conceituais como uma técnica que facilitou o processo de aprendizagem (54%) e o grupo fechado na rede social como a atividade que levou a uma melhor discussão e compreensão dos conteúdos (77%). Todas as técnicas adotadas contribuíram positivamente. Assim, as alternativas didáticas ao uso de animais nas aulas possibilitaram a transmissão de conhecimentos, poupando um pequeno número de animais do sofrimento e seguindo valores éticos.
Palavras-chave: Métodos alternativos; Farmacologia; ensino e aprendizagem

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Introduction

The 3 R's deal with the principles of Replacement, Reduction and Refinement guiding many countries in the use of animals in scientific activities. The 3 R's were first described in 1959 by William Russell and Rex Burch in the book called Principles of Humane Experimental Technique (TRÉZ, 2014). *Replacement* refers to the preference of use of non-animal resources whenever possible to achieve the same scientific goal. The *reduction* refers to methods that enable researchers to obtain comparable levels of information with a minimum number of animals, or get more information from them, aiming to reduce that number used in each experiment. *Refinement* refers to methods that alleviate or minimize potential pain, suffering or distress and improve animal's welfare, reducing to an absolute minimum the amount of suffering imposed to the animals that are being used (FLECKNELL, 2002).

In Brazil, in the year of 2008 it was established the Law n. 11.794/2008, known as "Law Arouca", which states that it is the responsibility of the Ethics Committee on Animal Use to control the teaching and research activities that are taking place in universities, helping professionals in the biomedical field, as well as registering the institution in the National Council of Animal's Experimental Control (BRASIL, 2008). This legislation is more likely to contribute to the training of new professionals with ethical values of respect for life and responsibility on the part of teachers, adding these values in the training of students.

Brazilian universities are still employing the harmful use of animals both in teaching and researching activities. There isn't an accurate knowledge in terms of number of animals wasted, but it is known that they has been employed in great proportion. Very often, students participate in practical classes involving animals in odds with its values and ethical principles, generating emotional shocks (BAUMANS, 2004). Then, it is observed that the use of animals in teaching/learning is controversial, generating discussions and questions, and along with it, the proposed alternatives.

Alternative methods are procedures that aim to replace or reduce the use of live animals and refine methodologies with the objective to not only reduce animal's pain or suffering, as well as to prevent the unnecessary exposure the students to practical learning methodologies with animals that are very well described in literature (BAUMANS, 2004). The use of alternative instruments in teaching/learning is sometimes not well accepted by part of scientific society, claiming that these techniques are not able reproduce the aspects and conditions found when animals models are employed, because they do not show the dynamics of interaction between different systems along the organism. However, the alternative models are a reliable way to provide an overview of the whole procedure, in addition to present a great deal of security in real situations at classroom, especially in practicing surgeries procedures, because it allows the students to repeat the procedure several times (DEWHURST, 2011).

Among some alternatives methodologies that can be easily implemented in order to reduce or in sometimes even replace the use of animals in practical teaching is the use of social networks as a tool to explore and discuss pharmacology contents, and conceptual maps helping them to reorganize ideas and a tool to facilitate the pharmacology study, and for last, the design and making of pharmacology related contents material to be exposed to the students of other health courses in campus environment that had proven to be effective regarding students learning.

Several reports describe the implementation of alternative techniques to the use of animals in practical, such as communication technological innovations and information through educational software (OKADA, 2014) and the use of social networking websites (BORGES, 2014: JHA, 2016), as a tool to keep up the interest of students, improving the learning skills and enabling the teaching in different areas. Increasingly, social networks are nowadays more present in the daily life of students. More than a way of entertainment,

they may be used as work tools by professors at university to promote a better understanding and discussions about what is discussed in classroom. Social networks grow exponentially in Brazil and they are among the ones with an increased number of visits per day on web, sometimes even exceeding email services. At this scenario, Facebook® is the largest social network in the world, counting with over 500 million users (NADKARNI, 2012), and an estimated number of 16.6 million new memberships in Brazil in the last six months, spending an average of 7.5 hours per month connected to this social network (DA SILVA, 2014).

Talking about Facebook® (Facebook®, Inc, Palo Alto, CA), it features interaction facilitators, including the friends list, the postwall, pokes, status, events, photos, video, messages, chat, groups and likes (JHA, 2016). The success of Facebook® can be attributed to the need to belonging: desire for interpersonal attachments as a fundamental human motivation (DIVALL, 2012). The closed groups allow users to create and join in interest themes and they were reported on science education (DIVALL, 2012: EL BIALY, 2014). The advantages of using this tool are the inherent potentials in boosting e-learning (EL BIALY, 2014), self-perceived likelihood of being exposed to course announcements, online discussions, and external links (DIVALL, 2012) and allowed students to discuss topics more openly and encouraged classroom discussions of healthy aging topics (DE VARGAS, 2014; EL BIALY, 2014).

Through numerous static symbols, human beings were able to preserve information over time and release it into several parts. They include writing, paintings and maps, it was possible to preserve and disseminate knowledge. The ability of all means to preserve that knowledge enabled the autonomous learning of whom can provide these materials. Considering the difficulty that some students have to understand certain subjects presented in class, concept maps, which are nothing more than diagrams indicating relationships between key words and concepts, can be quite useful for a better understanding of the content. Mental maps are also a tool to improve the teaching and learning. Initially, the conceptual maps were designed to represent changes in children's understanding of science concepts (OKADA, 2014), but currently they have other applications. Conceptual maps are diagrams indicating hierarchical relationships between concepts (KINCHIN, 2010). They are able to create mental maps by presenting basic information related to specific themes and it is an accessible instrument to the classroom teaching (KINCHIN, 2010).

The university is a learning/teaching environment to be explored and improved, not only in traditional classes. Recreational activities in the form of interactive and popular games as a methodological alternative in vocational education as well as lectures and seminars (BORGES, 2014). In addition, studies compared the level of students learning of two different groups, with and without the use of laboratory animals in demonstrative practical class, considering aspects such as knowledge, memory of the subject and feelings of the students (BAUMANS, 2004), showing that the alternatives methods had positive results as a refinement to animal use and to be considered an easily applicable techniques.

Given the evidence that replacement of animals is possible and necessary in classes and following a trend for the protection of animals worldwide, this work brings alternative techniques regarding the use of animals, which are: the use of Facebook®, conceptual maps and proposing a new tool called "*Pharmaco Window*". The aim of this work was to implement those three alternative methodologies to replace the animal's use in teaching as an aid tool to the learning/teaching process in pharmacology classes. The evaluation of the students' perception regarding the understanding, acceptance and use of these techniques are demonstrated as follow.

Methods and materials

This study was conducted with 26 pharmacy undergraduation students that were enrolled in pharmacology classes at the UNIPAMPA, Brazil. All students were invited and accepted to participate the activities. Three alternative techniques to the use of animals were elaborated and implemented, always covering the topics that were being discussed in class and, at the end of the semester, a questionnaire was applied in order to analyze the student's perception related to employed models. The project was approved in UNIPAMPA Research Ethics Committee (1.694.106, 18/08/2016).

Facebook® group

A closed group, restricted to students, professors and pharmacology instructors, was created on Facebook®. After every theoretical class, the students were separated into small groups, and each and every group should publish posts related to specific previous

discussed topics of pharmacology in form of articles, texts, slides or exercises for further discussion among all students or on Facebook® itself, under the supervision of professors. The groups were formed by students' affinity and the selection of what to be posted was kept under the student's responsibility.

Conceptual maps

Conceptual maps were prepared by the monitor student of pharmacology, an advanced undergraduation student that was previoulsy approved in this class, about the topics discussed during the semester, such as nonsteroidal anti-inflammatory drugs, and anti-asthmatics and antihistaminic drugs. Conceptual maps were digitized and made available for students on a virtual platform. They were prepared using Microsoft® PowerPoint for Windows®.

"The Pharmaco Window"

Each and every one previously separated groups of students also received a topic to design, and develop, and post the material produced on a site that we called "The *Pharmaco Window*". "The *Pharmaco Window*" consisted in an outdoor space in a corridor were the universities laboratories are located. Actually, it was used the window of the Pharmacology Laboratory in which students of different health courses located on campus as well as the employees of the university pass by everyday. Therefore, we used this site to perform the exhibition of the topics discussed in class, through images and accessible language to all people, not only for pharmacy undergraduation students. Students could use any visual feature to adorn the selected theme in the window. Four contents were chosen, as follow: 1) Use of animals in teaching and research; 2) Nasal decongestants; 3) Allergy and anti allergic drugs and 4) Asthma and anti asthmatic drugs.

Questionnaire

At the end of the semester the students answered a questionnaire comprising 34 questions divided into the three approached techniques (Facebook® group, conceptual

maps, and “The *Pharmaco Window*" as well as general assessment regarding these alternative models. The questionnarie is available in supplementary material.

Results

Facebook® Group

The group studied was composed by 26 pharmacy undegraduation students, of which, 84% was female and the average age was 21.8 ± 4.1 years old. Only one student was attending the classes for the second time.

We verified that all students access Facebook® daily. Of these, 65.38% had reported spending an average of one hour on Facebook® a day, while 9 students (34.61%) had reported spending up to three hours.

All subjects answered to have had a fully participation in the preparation of the topic that was posted by their groups. The topics were related to drug/drug and food/drug interactions, drug-receptor interactions, blood-brain barrier, pharmacogenomic, Biopharmaceutical Classification System and pharmacokinetics calculations. Among the cited contents, those who caught more their attention was drug/drug and drug-receptor interactions, besides the pharmacokinetics calculations.

When the students were asked if the closed Facebook® group creation facilitated learning about the topics posted, 23 (88.46%) said "yes" and 03 (11.53%) said "no". When asked if the students discussed the posts sufficiently, 3.84% stated “for sure', while 53.84% said "maybe", 38.46% said "no" and 3.84% thought that "they have never discussed properly”

Regarding perceptions on the use of the group as a way to improve learning and discussion of related pharmacology contents, students commented that among the advantages, are the interaction between colleagues, improvement of learning and easy access to information. As a suggestion, they pointed out the possibility of all groups to post a material related to the subject of the week and not just one group, as it was done.

Conceptual maps

All students (100.0% said that they viewed and used mental maps. Table 1 shows the opinion of the students about some aspects of the conceptual maps.

Regarding the perception about the conceptual maps, students reported them as being didactic, dynamic and useful for organizing the studies. As a suggestion, they asked for adding more information.

Table 1 – Students' opinions (%) about the presentation, content and deepening of mental maps.

Aspect	Excelent	Good	Regular	Poor
Presentation of mental maps	65.38	34.61	0	0
Content of concept maps	53.84	46.15	0	0
Further development of conceptual maps	23.07	73.07	3.84	0

"*The Pharmaco Window*"

When the students were asked about the topics posted on the "*Pharmaco Window*", 23.07% said they knew about the topics passing by in front of the window, 3.84% through the posts on the Facebook® group and 73.07 % by both ways.

Figures 1, 2 and 3 present the answers regarding knowledge, presentation and content of the "*Pharmaco Window*", respectively. These question have been answered for each and every one of the proposed contents: "Use of animals in teaching and research", "Nasal decongestants", "Allergy and anti allergic drugs" and "Asthma and anti asthmatic drugs".

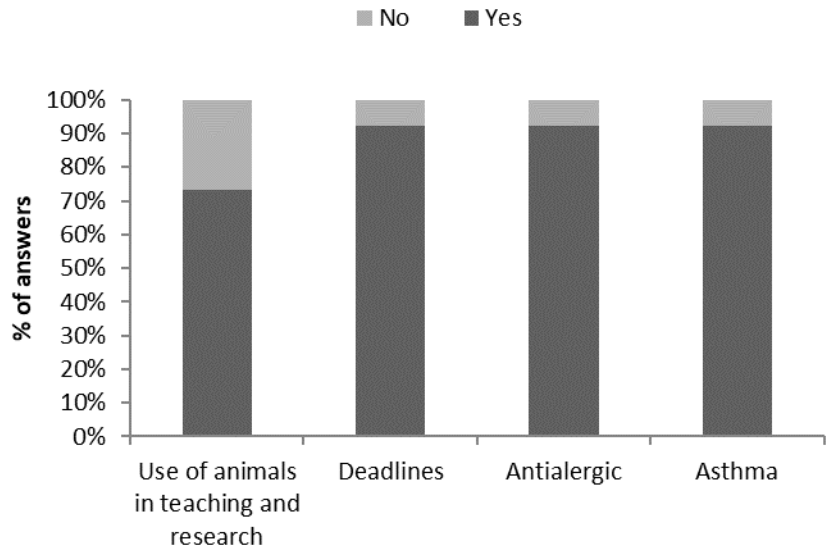

Figure 1 - Student's answer profile about the question: "Did you see the *Pharmaco Window*?".

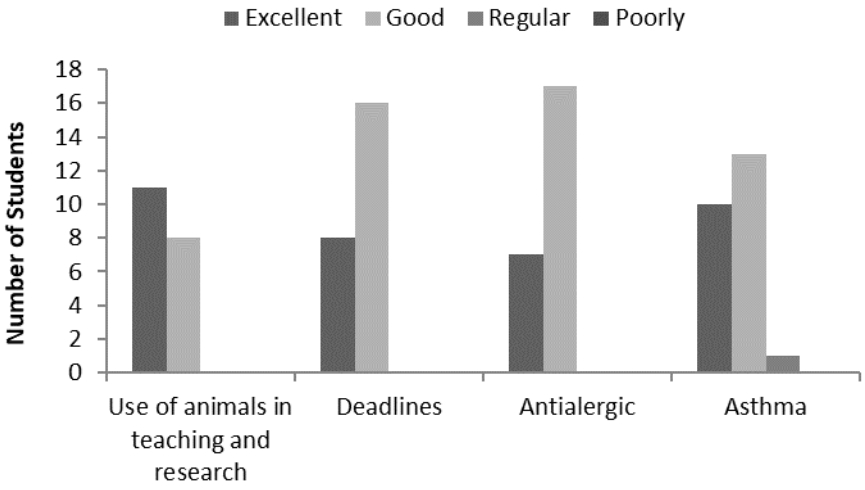

Figure 2 - Perception of students about the presentation of "Pharmaco Window".

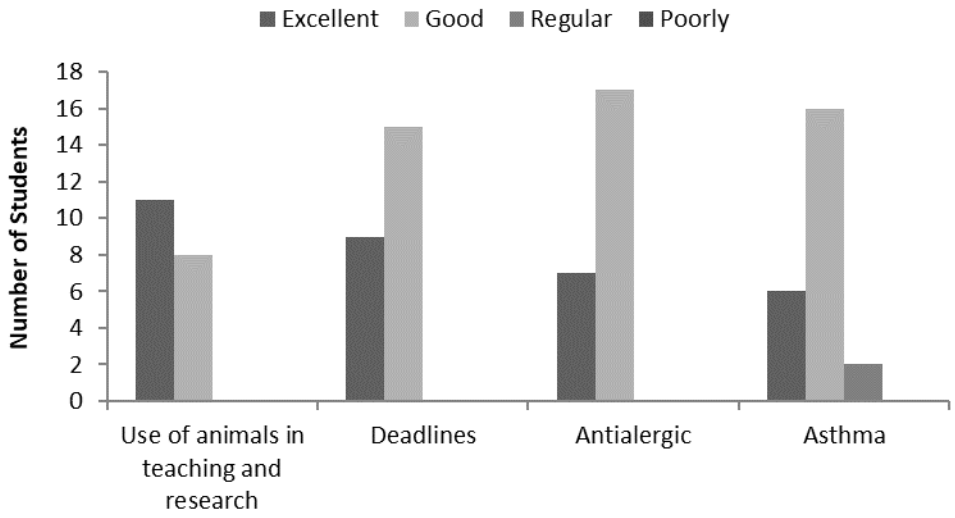

Figure 3 - Perception of students about the subjects of "Pharmaco Window".

Regarding perceptions on the "*Pharmaco Window*" as a way to improve learning and discussion of pharmacology topics, the students suggested a wider disclosure throughout the campus. As comments, they said it was a didactic form of dissemination of the content, and it could work together in learning process for students who prepared it as for the students who merely visualized it.

General evaluation

The 26 students were able to evaluate all the three strategies adopted by the course as productive. From the strategies, the one that facilitated the learning, according to them, were the conceptual maps (53.84%), followed by Facebook® group (23.07%) and the "*Pharmaco Window*" (7.96%). As the one that facilitated the discussions among the students, it was concluded that the Facebook® group (76.92%) were the most important tool for that matter, followed by the conceptual maps and, at last, the "*Pharmaco Window*" strategy (11.53%). Table 2 shows the student's opinions regarding some general aspects related to the alternative techniques developed.

Table 2 - Students' opinion (%) regarding the general aspects related to the Facebook group, mental maps and "*Pharmaco window*".

Questions	Sure	Maybe	No	I didn't get involved with any activity
Were the activities productive in terms of learning the issues presented in the discipline?	96.15	3.84	0	0
Do you think the activities can be used to improve Pharmacology classes?	92.30	7.69	0	0
Do the activities facilitate the understanding of Pharmacology?	92.30	7.69	0	0
Did the strategies meet your expectations?	88.46	11.53	0	0

When the students were asked about critics, suggestions and general comments, they have suggested that "*Pharmaco Window*" strategy should be implemented throughout the campus as posters and the contents should always be related to pharmacology. Another suggestion presented by the students was about the topics posted on the Facebook® group. The posts seems to be less extensive and easily comprehended, which could create a greater deal of participation and involvement of students in all activities. In general, they said that alternative techniques were quite helpful to the understanding of the contents discussed in classes.

Discussion

The use of animals had an improvement during the 20th century because of disciplines such as pharmacology, toxicology, immunology and physiology, whether for training or as a learning reinforcement. In present days, there are universities that support and encourage the animals replacement in teaching and for that matter, they features

programs for the non-use of animals (BAUMANS, 2004). The discipline of pharmacology traditionally uses animals in teaching/learning processes, being necessary the adoption of alternative techniques. Currently, animal models are accepted only when the proposed benefits outweigh animal's suffering, minimized through ethical principles in the trial (DEWHURST, 2011; FIDALGO-NETO, 2014). Hence, there is the importance of other methodologies that are capable of transmitting simple and effective knowledge and an overview of the process without the need of animal use.

Several reports suggest alternative techniques and reinforce its applicability in comparison to the traditional techniques already employed that involve the use of lab animals in practical classes (FIDALGO-NETO, 2014). Using the many existing alternative methods, a methodology modification and replacement of animals representing a way to follow ethical values can be made, incorporating the principle of the 3 R's to the training and qualification of students. To do so, it should be considered the economics and practical issues for deployment of alternative methods. The costs of biological models are still high if compared to the alternative methods, because they require technical support, equipment and physical spaces. Meanwhile alternative techniques only require an initial investment with little maintenance (DIVALL, 2012; EL BIALY, 2014; FIDALGO-NETO, 2014). This is an advantage for the alternative techniques that, besides being focused on ethical issues, also require an investment with a considerably lower or completely without cost, like the instruments proposed in this paper.

Educational practices were innovated with the use of new information and communication technologies in the universities, which modified the organization of societies. The innovations in microelectronics and computing have made possible the scanning, storage and transmission of information, making the 21st century to experience significant changes in the infrastructure of various social levels, such as the economy and the dissemination of culture, as well as in education, especially in universities, causing changes in the production of teaching materials and teaching/learning methodologies, making it more flexible and decentralized (FIDALGO-NETO, 2014). The social networks are increasingly present in the day-to-day, especially Facebook®, especially in Brazil (TRÉZ, 2014; BORGES, 2014; DE VARGAS, 2014). Because all students in our study use Facebook® every day, it was possible to use the closed group as an alternative method. Our results demonstrated that this tool has the potential to contribute in the process of

teaching/learning because of the frequency that students access such internet media. In a previous study performed in Brazil, Vargas (2014) demonstrated that the creation of a Facebook® group can be well accepted by the students and contributed in learning physiology, offering a tool to promote interest and encourage the involvement of students outside classroom. We obtained similar results, in which the Facebook® group was well accepted by the students and, according to them, facilitated learning about the topics that have been posted.

The conceptual maps are a very flexible technique and can be used in many situations, for different purposes, as a teaching or a learning technique (OKADA, 2014) or even a way of systematic evaluation (OKADA, 2014; KINCHIN, 2010). When asked about what strategy did facilitate more the learning, more than the half of the students considered to be the conceptual maps. This result shows that conceptual maps can be proposed as a potentially facilitating strategy of a meaningful learning (KIRKPATRICK, 2016).

The interest for alternative methods is growing within the scientific community, while it seeking to decrease the number of animals used in experimentation and also reduce the costs of the experiments. Certainly, alternative methods should be used whenever possible and the pursuit of these methodologies needs to be one of the targets of modern science (MORALES, 2008). So it becomes important to create or improve existing methods. In our study, the creation of the "*Pharmaco Window*" appears as a new strategy to be explored. This conquered the students, not only having a role in student learning, but also a social role, with a view to disclosure of basic information on issues related to day-to-day life of people that passing in front of the window.

The use of animals in any educational environment will inevitably have an impact, both for the animal and for the student. It is necessary to value more and more the concept of animal sentience and consequently the animal welfare increasing the ethical debate, guiding educational policies, leveraging the development of new efficient teaching-learning methods and ensuring animal welfare. Compared to previous years, we could be able to see a greater deal of participation on the proposed activities of the students, which certainly enabled a better understanding of the issues discussed in class and led to a fully approval (100%) of the students, unlike previous semesters where there was a degree of disapproval around 30%.

Conclusion

Replacement of animals for alternative models is possible in classes and they can help and develop the learning in practice, maintaining the same quality of education. Knowledge can be obtained from different sources, and also can help raising ethical values in students. Considering that these new instruments are increasing the interactivity in education, it is valid its contribution in learning of pharmacology, which were corroborated by the performance and interest showed by the students.

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