DEVELOPING FLASHCARDS AS AN INNOVATIVE TEACHING TOOL FOR THE PHARMACOLOGY CLASSES

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Abstract

At the top of student-centered learning, professors have the constant challenge of incorporating innovative, active, dynamic and often creative learning strategies. The development of teaching material by the own students is a technique that can improve learning by stimulating the interest, effort and motivation of them. The main objective of the current strategy is favoring the autonomous work of the student, facilitating the learning of Pharmacology and benefiting the collaborative work in those subjects where it is carried out. For this purpose, this proposal of teaching innovation consists of using memorization or mnemonic cards (flashcards) created by the students themselves as teaching material that facilitates the learning of the numerous drugs that are studied in the subjects taught by our department. Each student will make a single flashcard. From a template prepared by the coordinator, each student will look for the relevant information requested in it in bibliographic bases of recognized prestige. Once finished, it will be sent to the tutor who will correct the possible flaws or inaccuracies of the teaching material. All memorization cards will be posted on a website for this purpose, upon presentation by students to their classmates in three seminar sessions. The project will be developed during the first semester of the 2019-2020 academic course at the Faculty of Pharmacy of the University of Granada. The recipients will be students enrolled in three subjects taught in the first semester: Pharmacology I, Pharmacology III and Clinical Pharmacy. To carry it out, 5 phases are proposed: 1) Preparation phase, which includes the design of the materials on which the students will work, with a meeting between the professors to elucidate the sections that should be included and elaboration of the template on which they will work (This phase is already completed). 2) Execution phase, in which the students will make the flashcards, the professor will correct them and upload them to the web, therefore all students have access to them. 3) Evaluation phase: of the process and the results of the project. 4) We will automatically generate a digital version of the cards. They will be included in a spaced repetition flashcard program which will show more frequently the most difficult cards than the easiest to remember, to optimize the learning of each student. It continuously adapts itself to the progression of each particular student to personalize and improve the study over time. The software is free and open-source and available both for computers and smartphones. 5) Dissemination phase. The advantage of using this methodology compared to a traditional method, focused on the traditional master lesson, in which the student is a passive subject of the group that receives the information mainly through readings and teacher's exposure, is that through the use of flashcards, the student gets a ludic learning, which helps to deepen in the subject and increase the motivation.

Keywords: Flashcards; Autonomous Learning; Information and Communication Technologies (ICTs); Pharmacology

1 INTRODUCTION

Until recently, the Department of Pharmacology from the University of Granada has been teaching its subjects through the classical teaching methodology: master lectures presented by the professors and practical case studies that need to be solved by students, always directed by the lecturer. In this way, the responsibility of the current teaching of Pharmacology in most of the subjects is to higher extent form the professor, and the student has an underactive and secondary role. For a couple of years, we have tried to change this situation in several of our subjects by applying the project-based learning

(PBL) methodology in our lectures. We use appropriate situations or "scenarios", generally in the form of clinical cases, to facilitate student self-learning and the development of skills and competences.

The idea of using flashcards in the classroom to facilitate the study of Pharmacology arises from an analysis of the lecturers who present this initiative, since we observe a series of problems or teaching deficiencies in our daily activity, namely:

a) Even while immersed in the European Higher Education Area (EHEA), the methodology that continues to prevail is that of master lessons taught by the lecturer and supported by slides.

b) These kinds of classes are unattractive and tedious for most students in some cases. In addition, in surveys performed by the students, we have been told that in certain cases they consider them unprofitable since they have notes on different online teaching platforms.

c) Even being the class attendance compulsory, we observe high absenteeism in the lectures (both among students repeating the subject and those who are not).

d) We have groups of more than ninety students in many cases, so it is difficult to consider real teaching innovations in our groups.

e) The student who finishes the degree of Pharmacy has few information and communication technologies (ICT) skills and competences, as well as little or no experience when speaking in public.

f) In the subjects of Pharmacology, the student must learn, among others, about 150-200 drugs with their specific names and characteristics. Taking this fact into account, a considerable amount of autonomous work is necessary, constant involvement with the subjects and a continuous study throughout the semester. However, we have found that students are limited to study the subject in the last weeks next to the exam, therefore they do not consolidate knowledge properly and the confuse drugs and their characteristics.

g) Finally, we have verified that many of the drugs learned in a subject are not remembered in the next academic course.

All these reasons led us to promote memorization and retention comprehension the most important knowledge for a pharmacist: drugs and their characteristics (pharmacokinetic, pharmacodynamics, therapeutic application, correct use, interactions and problems that may arise, between others).

The idea raised in the current project arises due to the hobby of the coordinator to board games and specifically to the so-called "deck-building games" or deck builders. It has been observed how fans of these board games (including young children) can memorize complex names and data of the hundreds of cards that make up their decks.

From all the above, we believe that the students of the Pharmacology subjects could elaborate cards about drugs, containing relevant and summarized information and knowledge, therefore student learning is favored.

2   AIMS

THE TWO GENERAL OBJECTIVES that we pursue with this project are:

- Facilitating the learning and memorization of the most relevant aspects of the drugs taught in the different subjects where this teaching innovation project will be developed. In addition, we intend that, with the impact of the images used in each *flashcard*, the learning will remain in time and not forgetting the most relevant aspects from one academic year to the next.

- Achieving a greater motivation of the student to acquire the knowledge, attitudes and skills necessary for their future professional performance by providing them with a set of tools, sources of information, connections and activities that each student can use in the nearest future regularly for their learning (called *Personal Learning Environment*, PLE).

THE SPECIFIC OBJECTIVES pursued by this project we highlight are the following:

1 Developing innovative teaching techniques and strategies based on the development of teaching material by students.

2 Implementing processes that encourage the active participation of students in the construction of their own training and learning process.

3   Improving the digitalization of teaching and virtualization processes.

The cards will use images that help with memorization and comprehension. The type of image conditions the card made. That is why the last objective we set is to know the impressions of both students and professors of Pharmacology on the adequacy or not of using certain images in something as serious and important as Pharmacology for biosanitary students.

3   METHODOLOGY

This is a qualitative observational study, with a retrospective longitudinal temporal scope. This project is framed within a qualitative approach which allows capturing the reality in a very direct way, specifically the interaction with the students and the lecturer in the classroom. This qualitative analyzes the reality in its natural context and how it happens by interpreting phenomena, according to the students involved. The investigation of this project is an investigation-action type, since starting from the method of observation and identification of the problem, the project execution is undertaken. Action-research is the process of reflection by which in a given problem, where it is desired to improve practice or personal understanding, the practicing professional conducts a study (firstly, to clearly define the problem and in secondly, to specify an action plan). The execution phase was aimed at the development or application of the proposed activities, which were based on the programmatic contents of Pharmacology. To carry out the execution phase it was essential to rely on the flashcards, which were the main elements in the development of the activities and that in turn, were the bridge that connected the students with the drugs they should learn. The activities that were carried out carried a logical sequence, according to the teaching guide of the subjects of the Department of Pharmacology. An evaluation will be undertaken in the future to verify and establish the effectiveness of the action taken.

4   RESULTS

The teaching framework established by the convergence towards the European Higher Education Area (EHEA) involved a reformulation of the teaching methodologies, which must be based on learning and not just on teaching. This pedagogical model requires greater student participation, which thus becomes the center of the process. We believe that in the previous courses (2017/2018 and 2018/2019) we achieved that goal by applying project-based learning (PBL) in our lectures. Currently, n different subjects n different subjects we intend to expand the good results obtained in that subject to other subjects. However, working with PBL in groups of more than 90 students is a challenge almost impossible to address (especially since we teach in several groups and different subjects). As a consequence of the concern of several professors about the need to introduce innovative aspects in the other subjects of the Pharmacology Department, this teaching initiative arises, aiming to favor the participation and involvement of the students: they elaborate cards of memorization (*flashcards*) with relevant data about the drugs explained in the different Pharmacology subjects. Classic *flashcards* are a fairly common method to improve study at different stages of teaching. They usually consist of cards in which on one side a concept or question about the subject appears and on the other hand the definition or answer to the question. Students look at the front of the card and if they know what is indicated on the back, they remove that card. If they do not know the concept, they put the card back in the study deck so that they end up learning it by repetition and memorization [1,2,3].

Flashcards-Plus (FP) is a new concept of using traditional flashcards developed by students [3,4]. Students write a concept in the card and its definition on the other side based on the reference textbooks. In this case, in addition, the student must elaborate a new flashcard defining the concept in their own words. This favors memorization, understanding and retention over time. Finally, with the FP, the student must think a real example of the concepts explained, which improves further learning.

Based on this idea, an analysis was carried out based on: 1) documentation and scientific literature search on the subject; 2) search for other products of this type or other experiences in health areas; 3) approach to the idea and discussion with the other professors of the Pharmacology subjects. After performing these three steps, we established that each student must make a single card of a specific drug, which makes the correction easy to perform by the professor. Once the card is made by the student and corrected by the professor, in three seminars, the students will present and explain to their classmates the material made (5 minutes of presentation per student). In addition, all of them will have all the flashcards on a web page created for this purpose where they will find those of their

groupmates, those of other groups and those of other subjects. With this reservoir, we intend to facilitate the study and review of the different subjects.

As a result of this analysis, we specified the design of the memorization cards and the main sections to be discussed in them were determined (Fig. 1). As it is shown in Fig. 1, a typical concept/definition or question/answer *flashcard* has not been devised. Our *flashcards* are more similar to the cards used in the "deck builders" type board games in which characters with their names and fighting characteristics appear. In our case, it is necessary for the student must look for the concepts requested in each section in different reliable sources of information. In most cases, it is not enough to look for the information in a single Pharmacology book. They will need to use several books as well as medical bibliographic sources.

Figure 1. Template to elaborate the flashcards by the students. A. Front and back of the PowerPoint template that students will use to create the flashcards (text in Spanish). B and C. Front and back of the cards indicating the different sections that students must complete.

Each flashcard is divided into two parts or sides. On the back, the student must include the name of the drug, a drawing made by them or any image of his own that refers to some characteristic of the active substance, the pharmacological group to which the drug belongs, its mechanism of action, its main adverse reactions and interactions with other drugs (Fig. 1A). The reverse will include a brief explanation of the drug, an image with its structure, its therapeutic application and the year in which it was approved by the Food and Drug Administration (FDA) and the year in which the European Medicines Agency (EMA) approved its use (Fig. 1B).

These cards will be made on a template in PowerPoint. With it, the students will search for all the necessary information and will fill in each of the sections. This was done in a preliminary test that we carried out with some students during the 2018/2019 academic year (Fig. 2)

Figure 2. *Flashcards printed on paper prepared by Pharmacology III students during the 2018/2019 academic year.*

The study of the information will consist of stating the definitions and data. When all the cards of all the drugs that the student should study are available, we will create a deck with all of them and we will put a blank card at the beginning. The second card in the deck will be already a drug card. This card will be poked from behind until its name is revealed. With the help of the first card, the different sections of that drug can be said. If the student say it correctly, we take that card out of the deck, and if not, it is put to the end until it is learned (Fig. 3). This allows a self-learning in which each student establishes their times according to their memory abilities.

Figure 3. *Flashcard Deck in which the template card covers the other cards, so the student can check whether or not he knows the information of the drug.*

The problem observed in this teaching innovation was that each student had to print the cards on paper or cardboard, cut it out and prepare each card, which means time and money. For all of the above, we contacted Simon Verley, professor of the Department of Theoretical and Cosmic Physics of the University of Granada, and we decided that to carry out this teaching innovation we will automatically generate a digital version of the cards. They will be included in a spaced repetition flashcard program which will show more frequently the most difficult cards than the easiest to remember, to optimize the learning of each student. It continuously adapts itself to the progression of each particular student to personalize and improve the study over time. The software is free and open-source and available both for computers and smartphones.

With this idea, we intend to train our students in the realization of memorization cards that allow them to acquire diverse skills. Our teaching innovation aims for the student to achieve the following competences included in the Tuning Project:

1   Ability to analyze: Students will be able to establish the objectives to study from the chosen drug.

2   Ability to organize and plan: Students must complete their teaching material with perfectly established deadlines.

3   Oral and written communication: Students will present the flashcard they have prepared to all their classmates with brief oral communication in front of the tutor and their classmates.

4   Computer skills: Students must make cards with computer programs, applications or open web pages. The flashcard template is already prepared by the project coordinator in PowerPoint format.

5   Information management capacity: Students will carry out bibliographic searches of the drugs to deliver a single template document that will be provided by the tutors. Since the sections and space are very limited on the cards, the student must be able to manage the information, summarizing and deciding to include what is most relevant.

6   Problem-solving: In a pilot test carried out this year with some students, it has been detected that students encounter different problems in the literature search. This methodology puts them in the commitment of having to correct them and find solutions to challenges that do not meet the simple memorization of information.

7   Decision making: Students must choose which drug they will present, they must select the most relevant information to present and the type of image that will be featured in their flashcards.

8   Recognition of diversity and multiculturalism: Among our students there is an important number of Erasmus and foreigners from Morocco, Italy and Portugal, and all of them must present their work to their classmates.

9   Critical reasoning: After the presentation of each card the students will submit to questions discussing those doubts that arise.

10 Ethical commitment: Because they will study the medications in their different facets, students learn the ethical commitments they will acquire with what their patients will be.

11 Autonomous learning: Basic in the methodology that we will carry out.

12 Adaptation to new personal situations: Carrying out this project implies a paradigm shift in the study of Pharmacy student.

13 Creativity: Necessary for the elaboration of each one of the flashcards in general and the images of them in particular.

14 Motivation for quality: Flashcards will be presented in an oral presentation to their classmates, they will be evaluated by teachers, and that note taken into account in the final grade, and will be posted open with their names on the web that is going to create for this teaching innovation project. All of the above suggest a motivation for the quality of the work delivered by the students.

15 Learning through images: Image is a pedagogical resource that contributes to: 1) Understanding abstract content that is difficult to interpret; 2) The motivation to learn and deepen with complementary readings; 3) The presentation of new concepts; 4) The promotion of the memory of the contents learned and taught; 5) The promotion of authentic communication in the classroom and related to everyday life; 6) The stimulation of the imagination and expression of emotions; and 7) The activation of previous knowledge [5].

As previously mentioned, conventional *flashcards* favor repetitive learning. If the students do not know an answer, they will continue looking at that card until they answer it correctly. The effectiveness of this study technique is not clear. Golding et al. (2012) showed benefits in its use after the first exam, but these differences disappeared in the second test [1]. We believe that our proposal is more like Flashcards-Plus in which the autonomous work of the student as well as the power of images can improve the performance of our students. In addition, compared to other existing flashcards in the market, we consider that the realization of the cards by the student has several advantages:

- When prepared by students, the cards will be free. Those that exist have been prepared by large publishers and are especially expensive.

- The language will be in Spanish. Currently, there are only a few flashcards on drugs in the market in this language, marketed in May 2019 (Flashcards of Basic Pharmacology. Brenner) that, in addition, do not cover all the subjects taught by our department.

- The information on each drug is very wide, so the cards prepared by the students will be more focused on the study of the subject.

- The student will have to look for the information in reliable databases, therefore is not passive learning of simple memorization of the information.

- Sense of belonging: They will be prepared by the students themselves, so they will understand it as their own.

- Promotes collaborative work by making each student a flashcard and finally sharing them all. It is as if everyone made summaries of the subject so that everyone can study and review.

One of the main characteristics of *flashcards* is their mnemonic capacity, which, in addition, is reinforced in the section of the image in our case. These teaching materials will be used in subjects related to Pharmacology, a subject of great importance for the students on Health Sciences and, more specifically, for the pharmacist. Medications and drugs are something very serious, that is why the teaching members that are part of this project have mixed opinions about what type of images should be used. On the one hand, some components think that any image (provided it is not offensive in any terms) is valid if it helps students learn (Fig. 4). Others member of the team, on the other hand, consider that Pharmacology is a serious Science that should not be infantilized or reduced to images that are too simple (Fig. 4B). Figures 4A and 4C show drawings or schemes that are usually used in the Pharmacology books to explain the mechanisms of action of the different drugs. In Fig. 4B, more casual drawings appear that pretend to favor the memorization of the names or some interesting characteristics of the drug. Image 4B, for example, refers to the drug Anakinra. Anakin (Star Wars character) plus the symbol of the Egyptian god Ra (Anakin + Ra) are intended to help memorize the name of the drug. Anakin + Ra faces Palpatine/Darth Sidious (another Star Wars character) who suffers from osteoarthritis in his hands. Anakinra is a competitive antagonist of IL-1 receptors that exerts beneficial effects against rheumatoid arthritis. It is a second-line drug after Methotrexate (MTX) with which it is usually associated when it is not effective on its own, so it is one step behind the R2D2 character. In the 4D image you can see a Nintendo game console, which is intended to facilitate the learning of the name Nintedanib. In this case, the game console controls are lungs since one of its main indications is the treatment of pulmonary fibrosis. Nintedanib is a tyrosine kinase inhibitor, which after competitively binding to the ATP binding site in platelet-derived growth factor receptors (PDGFR) α and β, fibroblasts (FGFR) 1-3 and growth of the vascular endothelium (VEGFR) 1-3 blocking intracellular signaling pathways. These three key angiogenic receptors: VEGFR, PDGFR, and FGFR have been represented as the three buttons of what would be the controls of the game console.

As explained before, several of the professors involved in this teaching innovation and other colleagues in the Department do not see the use of type drawings represented in Fig 4B and 4D adequate, since, in their opinion, they are too childish, unscientific and do not take into account the importance and danger that drugs can cause. For all the above, we have decided, in parallel to the main objectives of this teaching innovation project, to conduct different surveys of both professors and students of Pharmacology to know their opinion, so that we can evaluate the design of our proposal and the adequacy or not of using certain images.
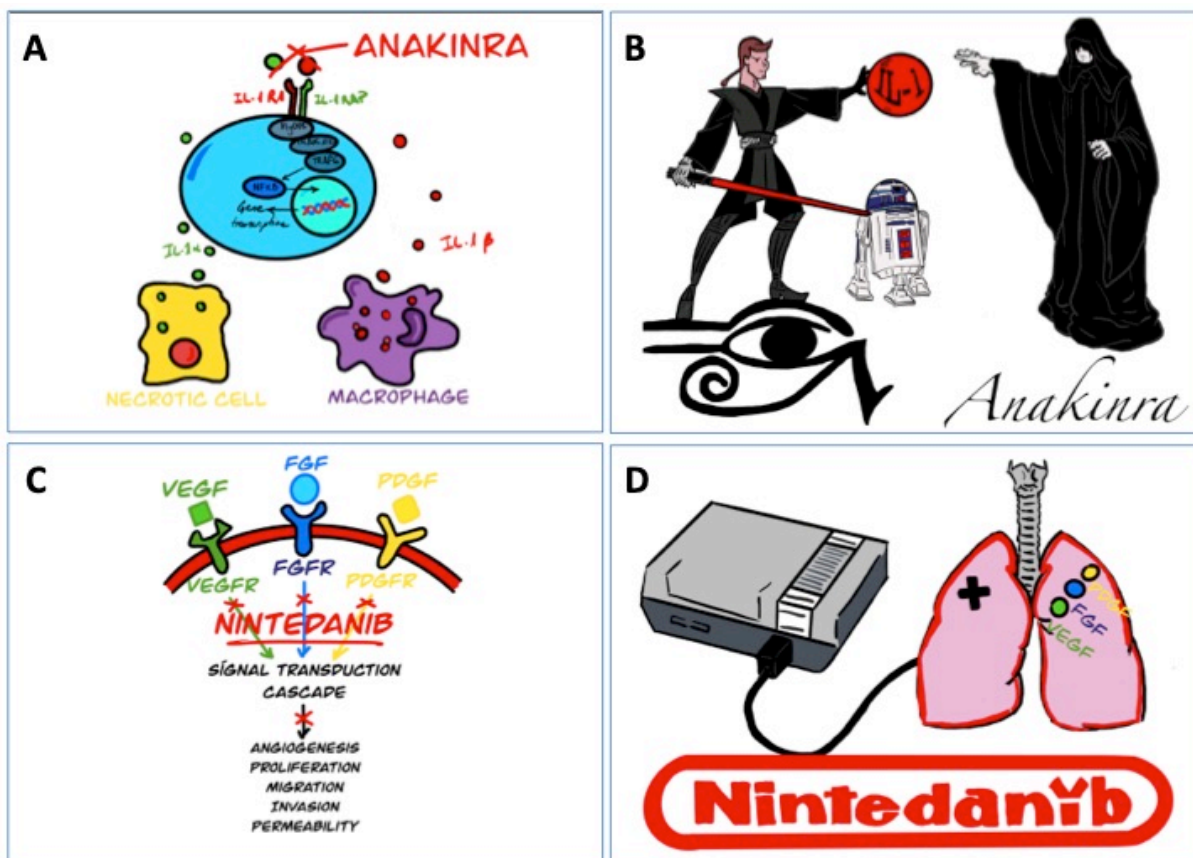
Figure 4. Examples of drawings that students could make on flashcards. A and C are typical schemes that summarize, in a visual way, the mechanism of action and signaling pathways that modify Anakinra (A) and Nintedanib (C). B and C are much less scientific drawings that aim to favor the memorization of the name of the drug and some of its characteristics

5 CONCLUSIONS

The authors of this teaching innovation proposal consider that the development of *flashcards* by students will favor the study, memorization, participation and motivation in the subjects in which it is applied.

At the end of the process, numerous flashcards will be generated. These documents prepared by the students will have a marked teaching nature, since they will summarize the most important aspects, and even information not provided in class, of the main drugs explained in the core subjects of the Pharmacology department.

Students will not only explain the work done, but also all flashcards will be posted open on the web that will be created for this purpose, which can undoubtedly mean a new way of transferring knowledge to society. Many of these cards will include advice on healthy lifestyles, recommendations of a hygienic-dietary type, rational use and the correct administration of drugs and medications. We consider that all this knowledge is of interest to any Health Sciences student, and we trust that the entertaining and summarized way in which it will be presented will favor that this information reaches other Pharmacology students of other specialties and other universities.

Finally, the use of flashcards can serve not only to promote the autonomous work of the student but also to make it better to improve their learning techniques by adopting information and communication technologies. It is pending to ensure that all students use the application as a first step that would facilitate extending the use of the application to other subjects taught at the Faculty of Pharmacy.

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teaching innovation project (PIBD BII 19-46) "**Elaboración de flashcards de fármacos para facilitar la memorización, la participación y la motivación del alumnado de Farmacia".**

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