An Experience of Using a Canvas-Based Template for Blended-Learning in a Master in Drug Discovery

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Abstract—Drug development is a complex process that requires multidisciplinary teamwork to overcome the uncertainty associated to the process. From this point, problem-based learning (PBL) methodologies are helpful to train future professionals dedicated to drug development in multidisciplinary environments. One of the strategies developed to design novel business models is Business Model Canvas (BMC), a strategy that has been widely employed in business schools, but not in scientific education. Thus, we wanted to verify if a BMC-like template was suitable for a PBL experience in the field of drug development using a blended-learning approach. The students of a research master subject were asked to create a joint project plan for the development of a novel drug for an unmet clinical need by making use of a BMC-like template as support for discussions on the project strategy, while combining online and face-to-face sessions. The methodology helped the students to learn about drug development, even in a blended-learning format. Most students considered that this methodology enhanced their participation in the working group and helped them to focus their arguments, proving that the employment of BMC-like templates is helpful to overcome the disadvantages of PBL experiences.

Keywords—graduate education, multidisciplinary education, cooperative learning, problem-based learning; drugs, drug development

1 Introduction

Drug development is a long process that usually lasts more than ten years and whose associated costs may exceed one billion dollars [1], [2]. One of the key issues in drug development is to previously identify the main strengths and weaknesses of the project in order to try to overcome the uncertainty associated to the process. This identification must be done considering bibliographic evidences and previous relevant experience [3]. Thus, it is important to have all that information organized before designing the drug development process with a previous brainstorming session performed in a multidisciplinary team. Furthermore, the development of vaccines during COVID-19 pandemics highlighted the importance of knowing the scientific and legal requirements of drug development and business models in advance [4]. Therefore, students must acquire a

clear vision of the importance of creating novel models for drug discovery in multidisciplinary environments. In this context, crossing knowledges and creative techniques for processes could help to achieve this objective.

Problem-based learning (PBL) is a learner-centered teaching methodology in which students work and discuss in collaborative groups on a problem related to the professional activity of interest, under the guidance of an instructor to propose a solution [5]. PBL has been widely employed in Pharmaceutical Sciences [6]. This methodology has several advantages, such as the fact that it motivates student learning and that it promotes their participation [7], [8]. Nevertheless, it has several disadvantages too, such as the fact that students find difficult to focus their discussions [9].

PBL relies on teamwork, which has been hindered during COVID-19 pandemics. Online education has been generalized since March 2020 [10]. It impeded face-to-face meetings and forced students to employ informatic tools to join for teamwork, making communication difficult [11], [12].

The Master in Drug Research and Development of the University of Santiago de Compostela is a research-oriented master for postgraduate students with a heterogenous educational background. It consists in a one-year master with 15 compulsory credits, 15 elective credits and a 24 credits master's degree final project. The described learning experience was performed in the 6 credits course Pharmacological Screening in Early Drug Discovery, that belongs to the compulsory part of the master. During the academic year 2020-2021, the University of Santiago de Compostela adopted a blended-learning modality due to the COVID-19 pandemics, with both face-to face and online classes, hindering presential teamwork.

Business Model Canvas (BMC) is a strategic management visual template for developing new business models. It consists in a nine blocks-divided large surface so groups of people can jointly start discussing and sketching business model elements with adhesive notes or board markers [13]. Initially, BMC was aimed to identify value creation to customers in a novel business by capturing the entity of interconnections in a multidimensional environment [14]. BMC template employment has been described for multiple purposes such as the assessment of curriculum implementation effectiveness [15], or in training in entrepreneurial and mathematical skills [16]. To our knowledge, BMC has never been employed in Pharmaceutical Sciences training. We considered that a BMC-like template could be useful to perform brainstorming sessions in the field of drug discovery and development.

Our working hypothesis was that an adaptation of the BMC template during 2020/2021 academic year could be employed in a PBL experience in drug discovery under a blended-learning context, and that this methodology would serve as a disruptive new way to make postgraduate students aware of the permanent need of multidisciplinary teams changing the drug discovery process in their future.

Therefore, we decided to start an innovative experience in teaching methodology in these pandemic times. It had the aim to develop and assess the employment of a BMC-like template to foster our student's participation and to help them to jointly work in a multidisciplinary creative design of the process of drug discovery, even under a blended-learning context.

2 Methods

The study was conducted during the fall-winter 2020 semester in the Master of R&D of Drugs of the University of Santiago de Compostela.

The course Pharmacological Screening in Early Drug Discovery has two different parts (see Figure 1): the first one is a theoretical-practical part, in which students attend lectures held by experts in drug development and they have a brief internship in the drug screening platform of the University of Santiago de Compostela. In the second part, the students must design, in multidisciplinary groups of five to six people, a drug research and development program in a particular topic. During the academic year 2020-2021, the design of the drug development project plan was done in an online format and the final presentation of the project was performed in a face-to-face format in front of the teachers.

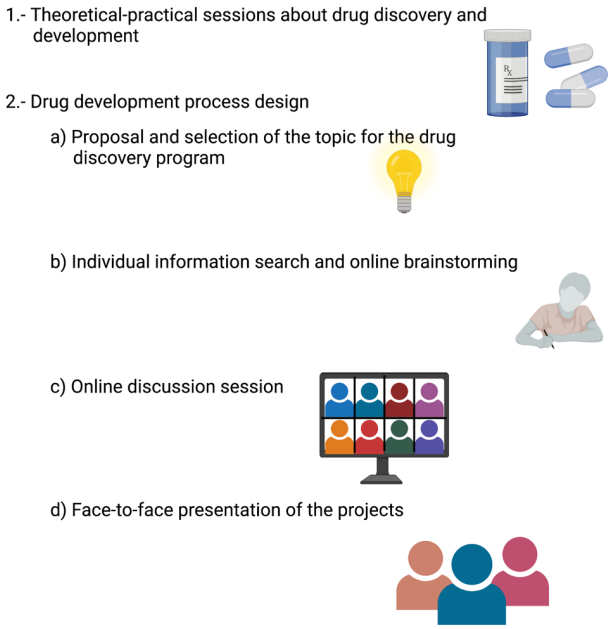

Fig. 1. Diagram of the process of the blended methodology followed in our experience. Created with Biorender.com

For the drug discovery process, sixteen students were assigned to three groups of five to six members taking into consideration their educational and professional backgrounds for the creation of multidisciplinary teams. Each group was told to discuss and choose an unmet clinical need and a road map for an early drug discovery process.

The first brainstorming session was carried out in an online format, employing Microsoft Teams and Microsoft Whiteboard (Microsoft Corporation, Redmond, WA, USA). A BMC-like template was provided to the students to focus the brainstorming (see Supplementary Figure 1). The BMC-like template contains a number of sections

in which students should post their ideas. In the center of the template there is the value proposition epigraph, in which the students should explain the target in which the drug exerts its effect and the scientific basis of the idea. Also, in the center there is the project goals epigraph with the main strengths of the idea. The right side of the template is dedicated to the profile of the drug, its pharmacokinetic and pharmacodynamic features, and to the characteristics of the patients that are going to be treated with the drug. The left side of the template is focused on the research to be done related to the novel drug: the screening cascade, which are the experiments to explore the affinity, potency and selectivity of the drug on the target; all the preclinical in vitro and in vivo experiments to evaluate its efficacy, toxicity and pharmacokinetics, together with an estimated chronogram for the development of these tasks and the technical resources needed. In the bottom of the template there are two epigraphs related to the budget of the project and the funding sources, and the analysis of competitors and the patentability of the novel drug.

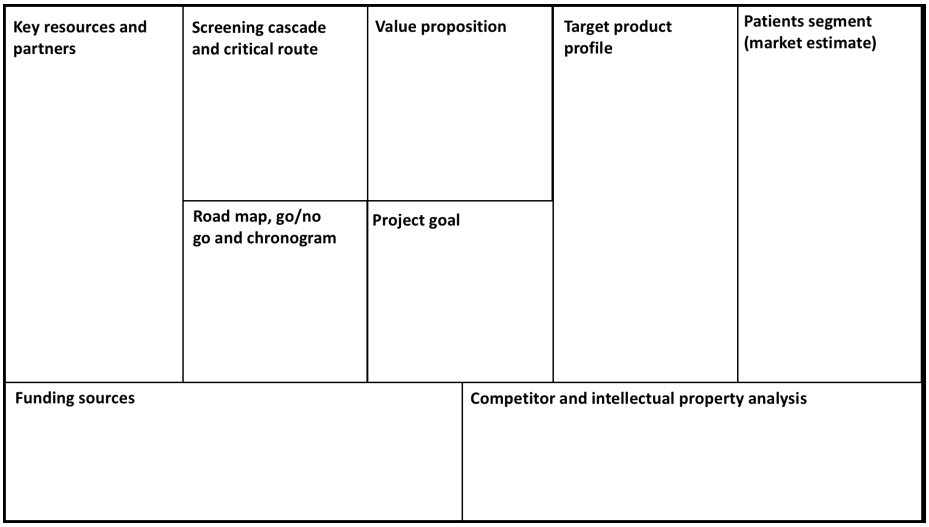

Fig. 1. Sup. BMC-like template employed for the online brainstorming of the PBL experience

Students had one hour to work individually, consulting the information sources from their homes, writing their ideas in virtual adhesive color notepapers, so that each student had a different color assigned, and sticking them in the BMC-like template of each group (see Figure 2).

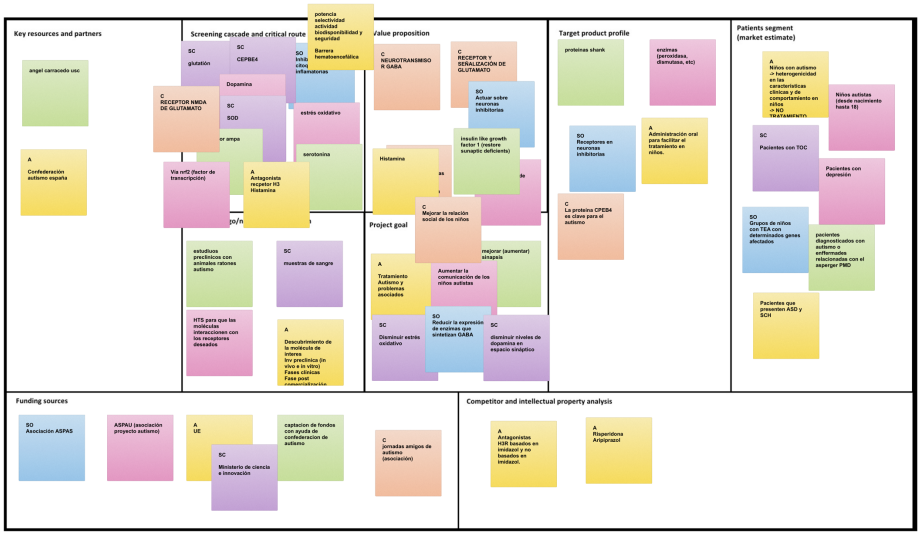

Fig. 2. A different notepaper color was assigned to each student to stick one's ideas in the BMC-like template

After the individual work, students of each team had to bring their ideas together discussing and defending them for thirty minutes. A spokesperson in each group communicated a summary of the collected ideas.

The ideas contributed by each member of the team and the conclusions of the group discussion were the basis for a presentation of the project that was exposed by all the members of each group before all their classmates and the teachers.

For objective evaluation of the students, a scoring rubric was employed taking into account both the participation in the elaboration of the presentation and the quality of their overall performance (see Supplementary Table 1).

Afterwards, a survey was conducted to gather the opinion of the students about the usefulness of the methodology to achieve learning and if it helped them to improve their performance. The survey was launched employing Microsoft Forms software (Microsoft Corporation). Thirteen students participated on the survey. Each item in the survey was scored between 1 and 5, being 1 the score assigned to a disagreement about the item and 5 the score for a full agreement with the item.

Table 1. Sup. Scoring rubric for evaluating students in the PBL experience

Student	**Slides format & appearance**	**Oral presentation**	**Concept skills**		**Challenges approaching**		**Student involvement**			**Final mark**
			Template employment	***Innovation and critical sense***	***Screening cascade***	***Selection and optimization of leads***	***Contribution of ideas***	***Spokesperson***	***Tutoring participation***	
	Max. 1 point	Max. 1 point	Max. 1 point	Max. 1 point	Max. 1 point	Max. 1 point	Max. 2 points	Max. 1 point	Max. 1 point	Max. 10 points

3 Results and discussion

Previously to the discussion session, each group selected the topic of their work. The chosen topics were treatment of the autism through H_3 receptor modulation, treatment of Alzheimer's disease through β-secretase inhibition and treatment of hemophilia through gene therapy.

The achievement of each student in the brainstorming was evaluated considering both the number and the quality of the contributions following the scoring rubric. The mean contribution per student was seven sticks. Students who posted more than seven virtual notepapers with significant contributions received the maximal score in this rubric criterion. Between both sessions ten students came to tutorial classes, achieving the maximal score in that part.

In the face-to-face presentation session, each group had to defend the rationale and the chosen road map of the drug screening process and face questions from the teachers on the project plan. The performance of each student during the presentation of the project was evaluated following the scoring rubric considering the commandment of a scientific vocabulary, their behavior during the presentation and the answer to the formulated questions, etc.

The average mark of the students was 9.4 out of 10, which was a satisfactory average achievement of the course objectives in these pandemic times.

At the end of the course, students were asked to express their opinion about the strengths and the weaknesses of the method. Most students (11/14) stated that the main strength of the methodology was that it boosted the participation of the students in the brainstorming. Also, a better part of the students (8/14) expressed that the method helps to integrate the ideas of the different members of the groups, offering a broad and multidisciplinary view about the topic. The main weakness of the proposed methodology was the lack of time to search information before the brainstorming session.

Regarding the student survey, students scored 4.36 that the method was useful for settling on their arguments in the brainstorming session (see Figure 3A). Students scored 4.14 that the method made easier working as a team (see Figure 3B). Students scored 4.21 that the method encouraged them to participate in the discussion (see Figure 3C). Students scored 3.79 that the method helped them to learn about drug discovery (see Figure 3D). These results demonstrate the usefulness of the BMC-like technology for the students.

Regarding telematic learning versus face-to-face methodology for the brainstorming session, twelve students (85.7 %) (see figure 3E) preferred to perform it online. When they were asked about the reason for their choice, most students (9/12) stated that this methodology enhances the participation of the students, allowing them to overcome the fear of ridicule and helping them to search information in scientific data bases during the brainstorming. Moreover, they considered that in face-to-face sessions the performance of real time bibliographical searches should be favored as it is in the online brainstorming sessions.

In spite of this overall view, a significant percentage of students (6/14) noted that the face-to-face methodology enhances the communication between the members of the group.

Teachers' feedback was requested along the course and upon completion. Teachers agreed in that the applied methodology fostered student's commitment on the teamwork and individual contribution from all the student team members, enriching the multidisciplinary and creativity of the drug discovery projects created. Moreover, this approach allowed students to improve several competences, such as the ability to work in multidisciplinary teams, the ability to handle information in a critical and analytical way, the ability to evaluate different criteria and to face decision making or the ability to propose novel approaches in drug discovery.

Objective assessment of the students' individual performance along the course was found well supported by the BMC-like template in combination with the whiteboard online application employed during the brainstorming session, overcoming difficulties at sustaining participants engagement during plain online group discussions.

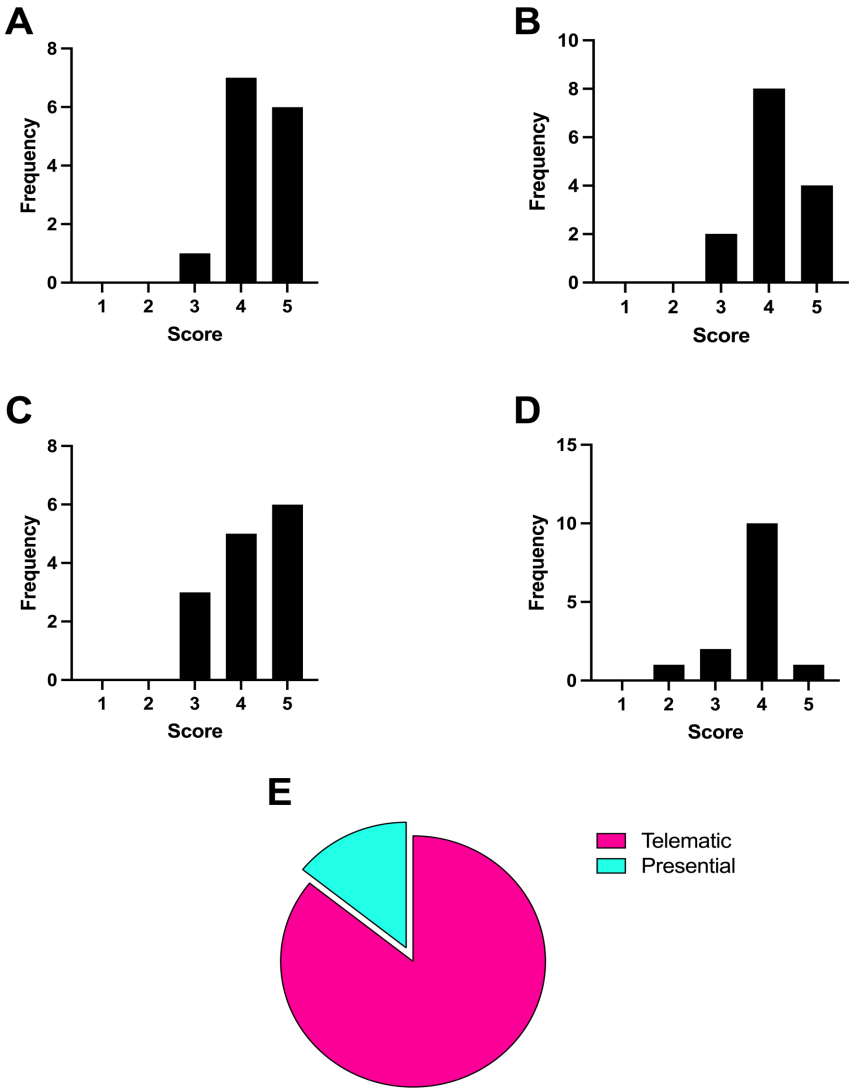

Fig. 3. Most students considered that the employed methodology was effective. The different panels reflect the conformity of the students with the following statements: (A) I consider that the employed methodology in the brainstorming session was useful for settling on my arguments, (B) I consider that the employed methodology encouraged teamwork, (C) I consider that the employed methodology helped me to participate in the discussion, (D) I consider that the employed methodology allowed me to learn about the drug development process. (E) Opinion of the students about if they preferred a telematic or an in-person brainstorming session

4 Conclusion

In this study we developed and assessed a novel blended-learning methodology to encourage the participation of students and to boost learning and creativity in drug discovery, in a drug development master subject with sixteen students. The results show that our methodology enhanced the outcome and the teamwork in these pandemic times, as well as the students' self-assessment, and it supported objective assessment of individual student performance in a blended-learning context. The employment of BMC-like templates in brainstorming sessions during PBL experiences is useful not only to replace the face-to-face teaching, but also to overcome the disadvantages of these learner-centered teaching methodologies, allowing to have quantitative data of student's participation and avoiding that the most participative students monopolize the discussion.

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