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CHAPTER 27

On social media, an innovative approach to project-based learning applied to the teaching of biochemistry

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ABSTRACT

Research in biochemistry education describes new approaches that include teaching with constructivist ideas, since the traditional approach with lectures has criticisms related to superficial learning. Thus, learning biochemistry should not only achieve the mastery of knowledge, but also critical thinking skills and the interconnectedness of knowledge. Although Case-Based Learning is the most frequent, active Project-Based learning, acting on individual and collective strengths have received attention in recent years. With the aim of encouraging learning by doing, experimenting, solving problems, working in a team, developing social skills, understanding, collaboration, partnership and responsibility, the activity "Scientific Dissemination Project" was implemented in the Integrated Biochemistry Curricular Unit of the different undergraduate courses of the Federal University of São Paulo, Diadema Campus in the pandemic. Since then, this activity has contributed to the final average of the students, positively impacting their performance. Considering that social networks can increase students' ability to think critically, promote media literacy, gain more scientific reach, and speed up deep learning, the result of this activity is disseminated to the community on an Instagram profile. This approach increased students' interest in biochemistry and science communication.

Keywords: Biochemistry, Project-Based Learning, Education, Graduation, Innovative Learning.

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INTRODUCTION

The field of biochemistry is a branch of science that studies chemical processes in living organisms, as well as the mode of regulation of the interactions of vital processes, that is, it is a science that unites biology and chemistry (Usman, 2017). Today it is one of the compulsory subjects in both basic and applied sciences, and is considered a difficult and unattractive subject for many students (Kumari et al., 2016). However, it is an interdisciplinary field that transcends traditional boundaries between academic disciplines, and includes areas such as health sciences, medicinal chemistry, biological chemistry, molecular biology, cell biology, physiology, and toxicology.

Research around biochemistry education describes new approaches that include teaching with constructivist ideas, since the traditional approach with lectures has criticisms related to superficial learning. According to Lang and Bodner (2020), the teaching of biochemistry in a more engaging way, using different approaches and assessment, results in deeper levels of learning on the part of students, in addition to being associated with the development of other socio-communicative skills.

According to Saputri et al. (2019), biochemistry learning should not only achieve the mastery of knowledge, but also critical thinking skills and the interconnection of knowledge. These thinking skills, in some studies, are termed higher-order ability (HOTS) (Miterianifa et al., 2021). A variety of strategies, models, and approaches are used to achieve these goals, the most common of which include active methodologies such as Project-Based Learning (Baker et al., 2011), Problem- or Case-Based Learning (Djidu and Jailani, 2016), and Meaningful Learning (Anwar et al., 2018). Case-Based Learning is the most common, especially when Biochemistry is inserted in the health and medical field (Sannathimmappa et al., 2019; Sulistyoningrum and Lusiyana, 2018), and one of the goals is the shift away from memorization-based learning. Research shows that the use of Case-Based Learning (CBL) in teaching biochemistry can facilitate learning in terms of understanding the theory and increase student engagement and interest (Kulak & Newton, 2014).

Another type of active learning is Project-Based learning, which acts on individual strengths and allows students to explore their interests within the pre-established context and inserted in the schedule of activities. This type of learning embodies the principles of providing challenging, complex, interdisciplinary work and encouraging cooperative learning, imparting authenticity to development. In practice, there are several steps that include, planning, implementation, and evaluation of real-world situations beyond the classrooms (Salve and Chavhan, 2022).

The use of technologies is also a strategy with positive results in the classroom. Among the technologies, we have the internet and the role of the internet and social media in our lives is indisputable. Apps like Facebook, Google, WhatsApp, Instagram, Twitter, YouTube, among others, have never been closer; Not only in our daily lives, but also in the scientific environment, reflecting the power of media on collective learning and exposure to new ideas. For example, the use of a video

in the classroom right after a lecture on the same topic points to improvements in both cognitive processing skills and learning outcomes related to logical thinking skills. Podcasts (three minutes long), embedded in a medical course, produced mixed results in terms of student performance, but were seen by students as a useful way to review material and prepare for assessments (Lang and Bodner, 2020).

The discipline or curricular unit (CU) of biochemistry is present in several courses within UNIFESP – Diadema Campus, such as Biological Sciences, Pharmacy (full and evening), Chemistry and Industrial Chemistry, totaling more than 200 students per year. This course, called Integrated Biochemistry, provides students with an integrated view of the chemistry of biomolecules, including enzymes, and their applications, and the pathways of synthesis and degradation of these biomolecules, highlighting the study of the processes of regulation and general integration of metabolism. This is a CU with very dense content, comprising 8 hours of class per week distributed in theoretical classes, various practical activities, review classes, case discussions and other evaluations in addition to the regular ones. Although the content is the same for all the courses in which the UC is taught, it is directed to the different specificities of each of them. Each practical activity at the UC has a specific objective and each year we seek to innovate in order to increase the students' performance. In this sense, between 2018 and 2019 two innovative activities were created with interesting effects on student learning: 1) didactic games and 2) science dissemination projects.

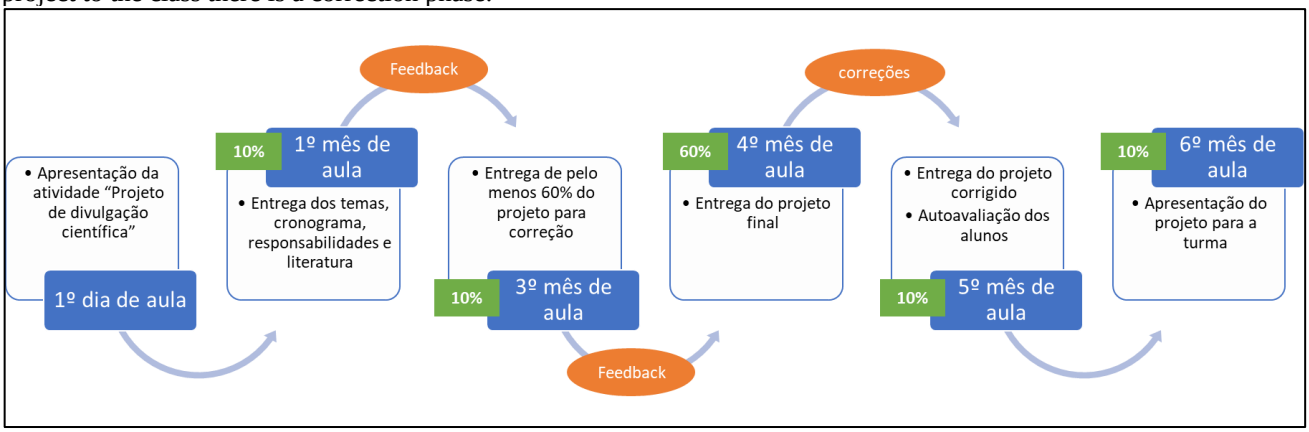
The coronavirus disease pandemic in 2019 (COVID-19) led to the abrupt implementation of distance education in universities around the world, including UNIFESP. In our own experience, this transition has resulted in communication difficulties and a marked disconnect between the student and the teacher. Despite efforts to engage students on synchronous meeting platforms and non-face-to-face activities (online lab tutorials, *quizzes*, case studies), the response to teaching activities has been pitiful. Even discussion forums used to engage students had low attendance rates, muted microphones, and cameras turned off. It should be noted that these observations were shared by other teachers in different public schools and universities in developing countries such as Brazil (Tadesse and Muluye, 2020; Hammerstein et al., 2021; Li, 2022). This created a sense of dissipation of information rather than engaged dissemination, making clear the need for a new communication channel, which would be effective in teaching the course contents, as well as encouraging the active participation of students in a familiar and comfortable environment.

On the other hand, with the pandemic, the "science dissemination project" activity exceeded expectations. In this activity, students select a topic of interest and develop it within their specialties, but with the commitment to include biochemistry as a theme in the action. As such, Project-Based Learning focuses on learning by doing, experimenting, problem-solving, teamwork, social skills, understanding, collaboration, partnership, and responsibility. In our case, different means of

presentation can be used, including podcast, infographic, magazine, comic strip, brochure, Instagram page, comics, among others, but always using a language that covers all types of audiences.

The main objective of this activity is to motivate students attending the Integrated Biochemistry course to produce content on a subject of their own choosing, with the opportunity to examine the task from different perspectives using a variety of resources, separating relevant from irrelevant information and managing the information they collect. In this activity, students learn that critical thinking is important for problem solving, work in groups and the final product is evaluated for quality and monitored throughout the semester by professors who assume the role of facilitators instead of leaders in the following stages (Figure 1):

Figure 1: Stages of the Scientific Dissemination Project as an activity within the semester of the Integrated Biochemistry course. The boxes in green are the percentages that the respective stage corresponds to in the final grade of the Project. At each stage there is feedback from the teachers regarding the progress of the project, and before the presentation of the project to the class there is a correction phase.



During the presentation of the activity, students are always suggested to choose topics that are not presented in the classroom, something that is new, that includes curiosity or everyday facts, where the main question can be answered with the fundamentals of biochemistry. With the first delivery, students are able to design an action plan for the project and teachers are able to assess how the problem or theme connects with the syllabus of the subject and its relationship with other subjects. The schedule at this stage is essential, so that there is the definition of a timeline and activities and responsibilities of each member of the group, as well as the delivery of the literature to be used demonstrates the quality in the search for references and the path that will be followed during the development of the project. After 2 months, students deliver the project with 60% of the final product completed, in this stage criteria such as choosing the most relevant subjects within the theme, quality of the language used, adequacy of the information to the desired target audience and theoretical content are evaluated. In the following months, there is the delivery of the completed project, accompanied by a correction stage, when the project is presented by the entire group to the class and other collaborators. As in Project-Based Learning the teacher's role is to monitor the work

and progress of the students, in each delivery there is always a feedback with rubrics, whether suggestions, criticisms and/or relevant questions. The contact serves to establish the student-teacher relationship, so that the students feel that there is a collaborative work and the teachers can effectively evaluate the learning process. After completing the work, students are asked to self-assess, reflecting their participation in all stages and creating an opportunity to reflect on the process as a whole, their learning and participation, in order to instruct teachers in the future.

As in this Scientific Dissemination Project, students are independent from the choice of the subject, responsibility is stimulated not only with teachers, but also with their colleagues. It is known that when students do not fulfill their responsibilities to their peers, they often face greater consequences than if they were only accountable to the teacher (Bell, 2010). With this, students have a greater motivation to take responsibility because they don't want to disappoint their peers.

At each stage of the Scientific Dissemination Project, a grade is established and this activity corresponds to 30% of the final average of the course. The implementation of the activity did not impair the students' performance over the years (Figures 2 and 3). On the contrary, in some courses there was even an increase in approvals (Figure 2).

Figure 2: Percentage of approvals in Integral Pharmacy, Bachelor's Degree Chemistry, Biological Sciences, Evening Pharmacy, and Industrial Chemistry courses from 2018 to 2023.

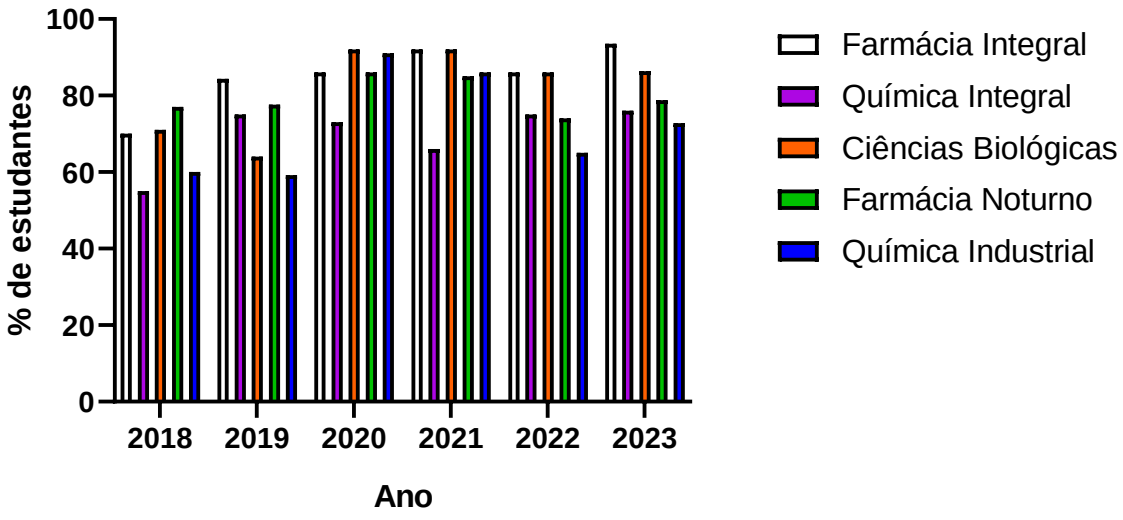
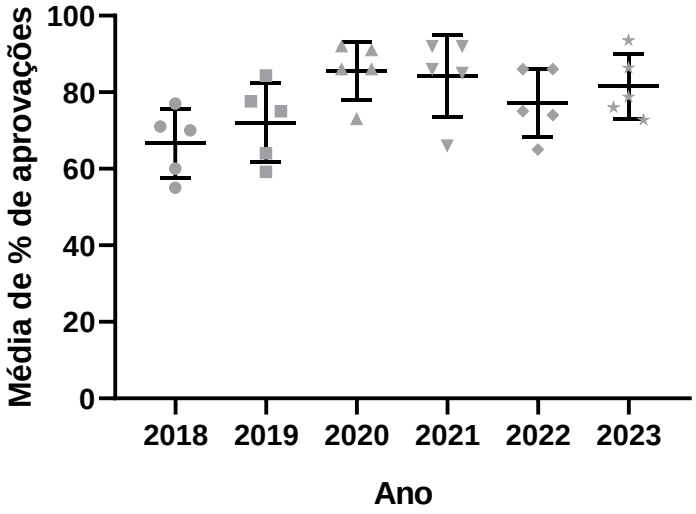
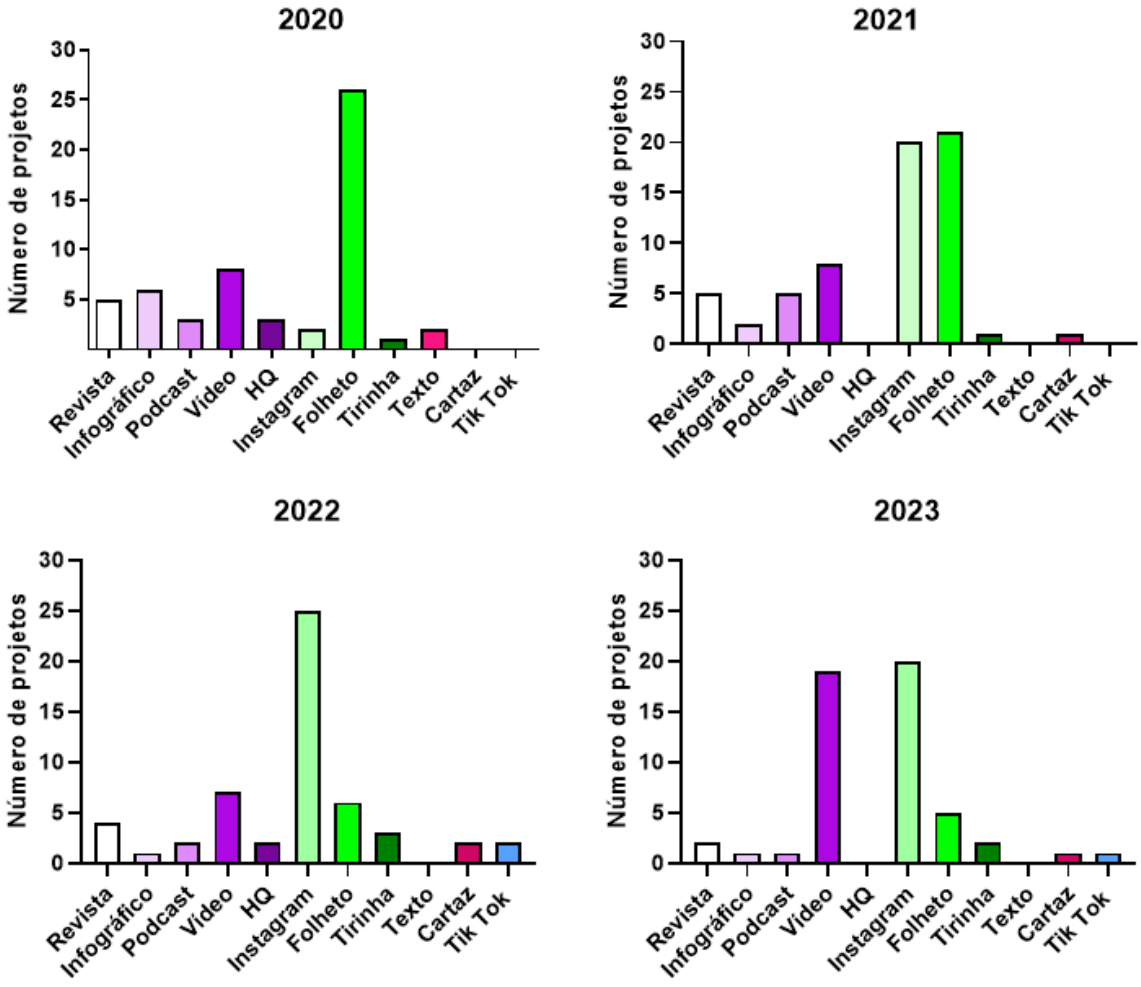


Figure 3: Mean and standard deviation of the percentage of approvals in the years 2018 to 2023.



Another aspect that can be observed is the diversity of forms of presentation over the years, with a significant increase in the use of Instagram and videos, including TikTok, probably due to the greater interest of this generation in social media (Figure 4).

Figure 4: Project presentation formats in 2020, 2021 and 2022.



These projects show biochemistry in the different aspects of chemical processes, in the "comparative biochemistry" of different species and also in diseases, drug actions and toxicological aspects of medicines, but as common characteristics, a simple and motivating language, different formats and a lot of creativity. As students dedicate themselves to the project over the course of a school semester and are expected to produce an authentic, high-quality result, it is only fair and motivating that their work is recognized and publicly disclosed so that students can engage and be proud of the final result. It is believed that the public exhibition and recognition of the work convey the message of appreciation of the student linked to the project (Salve and Chavhan, 2020).

The commitment of the students and the quality of the projects led to the possibility of directing this activity to the production of scientific content involving biochemistry for the general public. Thus, a curricular extension project was created so that the best projects presented in the classroom are disseminated to the community on an Instagram profile.

Extension in Brazilian Higher Education can be defined as the activity that is integrated into the curricular matrix and the organization of research, constituting an interdisciplinary, political, educational, cultural, scientific, and technological process that promotes transformative interaction between higher education institutions and other sectors of society, through the production and application of knowledge. in permanent articulation with teaching and research (Ministry of Education, 2018). With this extension project, there is the possibility of uniting students from different courses and different years, adding knowledge and actions.

Several studies have shown that social media can increase students' ability to think critically and promote media literacy, gain more scientific reach, and streamline deep learning (Chen and Bryer, 2012; Geyer, 2014; Manca, 2020). The idea that social media can serve as a tool in education is based on research showing that young adults use social media more than any other demographic (Coleman and McCombs, 2007). Consequently, academic interest in social media has increased dramatically over the past decade, with more recently developed platforms including WhatsApp, Pinterest, Snapchat, Instagram, and TikTok only receiving attention in recent years. In fact, the latter two are the most popular platforms among adolescents and young adults, explaining the greater interest of students in developing projects in these formats in recent years (Figure 4).

According to Dixon's article, published on the Statista website, in 2021 there were 1.2 billion active Instagram users per month, but in 2023 there were already almost 2 billion users per month (Dixon, 2023), which makes this resource a tool for disseminating information as well as disinformation (Arceneaux and Dinu, 2018; Chan et al., 2020; Ye et al., 2020). In addition, they have been evaluated as tools to involve specific populations (Seltzer et al., 2017), being an interesting resource for scientific dissemination, whose main objective is to democratize access to scientific knowledge and establish conditions for scientific literacy. It should be noted that scientific

communication contributes not only to the understanding of science, but also to the inclusion of citizens in the debate on specialized topics that can impact their lives and work (Bueno, 2010).

The literature highlights that social media has the potential to significantly expand the reach of science communication, facilitating direct communication between scientists and society (Carpenter, 2015). Considering the role of popularizing Science and Technology (S&T), the following objectives were central to the activities developed on the Instagram page: 1) to play an active role in the circulation of scientific knowledge in order to help combat disinformation ("fake news"); and 2) to help broad sectors of the population understand the world in which they live. In order to work with the public of children of different ages, young people and adults, as well as Basic Education teachers on simple S&T issues, advancing in complexity and thus giving visibility to an infinity of knowledge. Considering the proposal and respect for the various users of the page on Instagram, it is essential to have a selection of quality content and references.

Thus, for publication in the @bioquimatch_unifesp profile, the best projects developed at the UC are selected, but there are also independent projects developed by extension students, who have already studied Integrated Biochemistry and are interested in continuing in the extension project. In general, these publications include commemorative dates and trending *topics*. Some projects have a development stage in the laboratory and are disseminated in the form of a video, combining different knowledge and skills that explain each process. In this case, there is the stage of adapting the theoretical content to practice and its adaptation to a more colloquial language. To interact with the virtual audience, polls are carried out for topic suggestions, criticism in forums, lives with questions, dialogues on current topics, interaction in stories, likes and messages on the profile.

All subjects covered, such as posts or videos, are developed with the search for bibliographic references, planning and strategy for assembly, execution and publication. The impact of each publication is assessed through opinion polls, social media analysis, and other relevant methods. As it is a commercial account, it is possible to analyze data to evaluate the results of the profile, such as number of participants, comments, reach. In the last two years, there has been an increase in the number of "followers" and positive reviews of the publications, in addition to an increase in the number of students interested in participating in the publications of the Instagram page. Extension students also work with freedom of choice and collaboratively in the development of content, learning skills that are increasingly important for the twenty-first century, such as the ability to work in teams, solve complex problems, and relate knowledge of biochemistry to everyday issues and questions (Barron and Darling-Hammond, 2008; Miterianifa et al., 2021).

In active learning, motivating and engaging students is challenging for even the most experienced teachers, as there are different learning styles, students' cultural and ethnic backgrounds, variety of preconceptions established in traditional teaching, and the current problems we face of

critical content selection. In this regard, there is broad agreement in society to recognize the importance of education as the way to develop sustainability. Associated with the fact that scientific learning brings with it the transmission of human values, thus contributing to a more complete formation of individuals.

Thus, the development of scientific culture is of interest in the educational environment, especially when discussing the formation of critical citizens, capable of acting consciously in a world of constant scientific and technological advances. It also enables society to think about controversial issues that include conflicting interpretations and decisions, issues that require the development of social critical thinking. The importance of public universities as knowledge-generating centers is emphasized here. In this context, the university has an effective role not only in scientific dissemination, but also in the scientific literacy of society.

In the activity Scientific Dissemination Project based on the fundamentals of Project-Based Learning, students develop skills with critical thinking regarding the choice of bibliography, collaboration skills, since it is essential that the activity is developed in a group so that the different skills of the students can complement each other; communication skills in order to present simple solutions to complex problems; responsibility since there is freedom of expression. choice in terms of the theme and conduct of the project; contextualization, by the students' ability to apply what they learn in the classroom, in everyday issues and the use of technological tools for information and communication. Thus, it can be concluded that both the active participation of students in the Science Dissemination Project activity and the increase in the number of extension students in the Instagram Project and the growing increase in followers of the Science Dissemination page (@bioquimatch_unifesp), reflect the acceptance of this type of activity by undergraduate students as a way of learning and developing scientific literacy.

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