

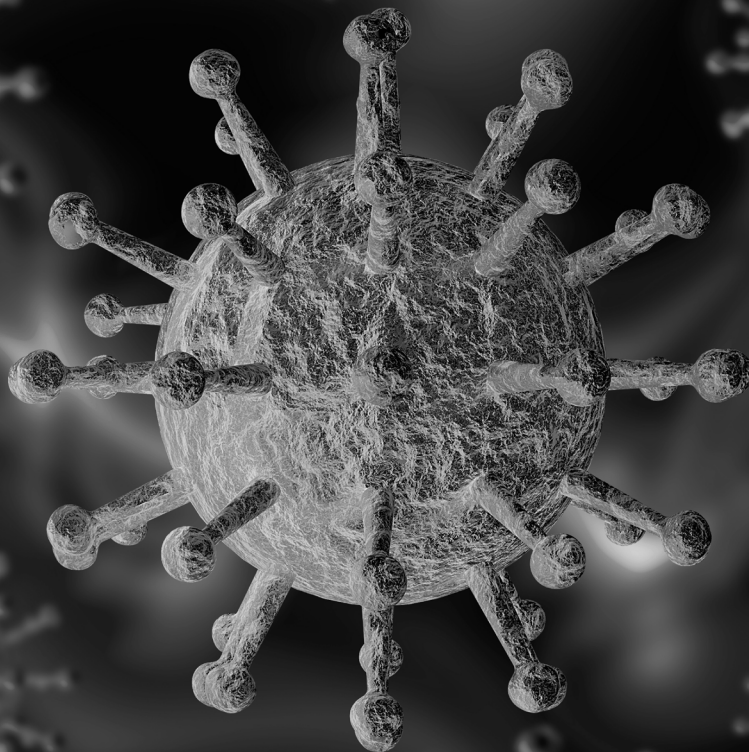
Larissa Maranhão Dias
(Organizadora)

Microbiologia:

Geração de conhecimento e caráter multidisciplinar

 **Atena**
Editora
Ano 2022

2



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Desde a criação do microscópio e com ele a descoberta do mundo microscópico os microrganismos passaram a ser de interesse comum a diversas áreas; inicialmente na saúde e conforme suas descobertas esta temática ramificou-se para outros campos, como as ciências biológicas e nas áreas de ensino. Atualmente, a Microbiologia é um assunto em crescimento exponencial.

Assim, de forma colaborativa e integrada o volume “Microbiologia: Geração de conhecimento e caráter multidisciplinar 2” apresentada nesta edição reúne estudos desenvolvidos em instituições de ensino brasileiras que contribuem na grande área da Microbiologia através de pesquisas de cunho experimental e de caráter bibliográfico.

Esta obra tem início com o uso da metodologia de sala de aula invertida no ensino de graduação para o componente curricular de Microbiologia de Alimentos, realizado durante a pandemia de Covid-19. Esta análise teve um rendimento positivo com a metodologia utilizada, contribuindo de forma significativa com a aprendizagem dos discentes.

Após, é apresentado uma pesquisa que relata a pressão seletiva sob os microrganismos em função da pandemia do Covid-19. Neste artigo, apresenta de que forma o uso inadequado de antimicrobianos de amplo espectro contribui na propagação de bactérias resistentes aos principais antibióticos usados em âmbito hospitalar. Ainda relacionado a área da bacteriologia, a terceira seção deste volume conta com um experimento que envolveu análise de amostras biológicas oriundas de profissionais da saúde, de um hospital público, contaminados por *Staphylococcus aureus* com perfil de resistência a antimicrobianos. Esta análise traz a importância do emprego correto dos EPI'S e hábitos de higienização.

Além disso, essa publicação conta com três trabalhos que abordam a área da Micologia, presentes no quarto, quinto e sexto capítulos, respectivamente. O quarto estudo **propõe** uma alternativa sustentável para uso de resíduos quitinosos oriundos por indústrias de frutos do mar através de quitinases fúngicas por processos biotecnológicos. A seção seguinte relata sobre infecções da mucosa oral causadas pelo fungo oportunista *Candida* e uma alternativa de mitigar este cenário através da utilização de filmes oroadesivos associados com produtos naturais. Por fim, o último capítulo discute sobre o monitoramento da qualidade do ar devido a presença de esporos de fungos anemófilos em suspensão, que podem desencadear infecções sistêmicas graves em indivíduos imunocomprometidos.

Reconhecemos o potencial dessa obra em primeiro lugar pela qualidade dos trabalhos aqui apresentados, e em segundo pelo campo em potencial, corroborando para futuras novas discussões na área microbiológica.

Assim desejo a todos uma ótima leitura!

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USE OF FLIPPED CLASSROOM FOR FOOD MICROBIOLOGY LEARNING DURING THE COVID-19 PANDEMIC

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Covid-19 pandemic. The investigation evaluates the students' acceptance of the flipped classroom methodology, and its contributions to the undergraduates' learning. The students were enrolled in the study of Food Microbiology while participating in online classes. The data was collected through an online questionnaire surveying 17 university students. The results showed that the students recognized the relevance of the subject and considered that the adaptations made in online classes were pertinent to their learning and 94% percent of the students described that the flipped classroom contributed to their knowledge about Food Microbiology. Regarding the adaptations in laboratory activities, 53% considered them good or excellent, and 47% considered them regular or poor compared to presential classes. These results suggest that flipped classroom during online classes contributed to student learning and engagement during the Covid-19 pandemic. **KEYWORDS:** Higher education. Remote teaching. Active methodologies. Laboratory.

ABSTRACT: This study describes a flipped classroom design that had been applied to Food Microbiology learning during the

USO DE SALA DE AULA INVERTIDA PARA APRENDIZADO DE MICROBIOLOGIA DE ALIMENTOS DURANTE A PANDEMIA DE COVID-19

RESUMO: Este estudo descreve uma proposta de sala de aula invertida implementada no ensino de Microbiologia de Alimento durante a pandemia de Covid-19. A investigação avalia a aceitação dessa metodologia pelos universitários e as suas contribuições para o aprendizado de graduandos. A coleta de dados com 17 universitários foi realizada por meio de questionário on-line. Resultados mostraram que os alunos reconheceram a relevância da disciplina e consideraram que as adaptações realizadas no ensino remoto foram pertinentes para a aprendizagem e 94% dos estudantes identificaram que a sala de invertida contribuiu para a construção do conhecimento sobre Microbiologia dos Alimentos. Quanto às adaptações nas atividades laboratoriais, 53% consideraram boas ou excelentes e 47%, regulares ou ruins, tendo como referência as experiências presenciais. Esses resultados sugerem que o uso da sala de aula invertida no ensino remoto contribuiu para a aprendizagem e envolvimento dos estudantes durante a pandemia de Covid-19.

PALAVRAS-CHAVE: Ensino superior. Ensino à distância. Metodologias ativas. Laboratório.

1 | INTRODUCTION

The food microbiology discipline is essential for several university courses, such as pharmacy, nutrition, food engineering, and veterinary medicine. The main objective of this course is to introduce students to the microorganisms present in food and their importance in disease development, food spoilage, and the main consequences in the food production chain and nutritional composition.

Before the Covid-19 pandemic, face-to-face courses were held twice a week, and the professor had direct contact with students, with the theoretical classes being followed by practical classes in the laboratory. However, university education had to be reformed, and students began learning online at home. Therefore, one of the main pillars that enables the study of undergraduate science became out of reach: the laboratory (Abbey and Howley, 2020). The primary limitations of online classes are related to students, since some do not have a good internet connection or even a device to access the courses. To address some learning disabilities, Abbey and Howley (2020) recommended using group activities such as case studies, presentations, and debates to get the students engaged and active.

The flipped classroom model, created in 2007 by professors Jonathan Bergman and Aaron Sams, has been widely used during the Covid pandemic. This model aims to optimize time, which is often scarce. The professor prepares video/interactive lectures and makes the material available to students before class, using the class time to discuss and apply advanced concepts (TUCKER, 2012). The flipped classroom has shown several advantages in different perspectives: increasing learning performance, motivation, and engagement, from the students' perspective, and teaching flexibility and individualized teaching from a pedagogical standpoint. In addition, the student-instructor interaction and the feedback of the managed content is also optimized (AKÇAYIR and AKÇAYIR, 2018). Several studies

reported positive experiences using a flipped classroom during the Covid pandemic, reporting engagement, learning, and attention improvement during classes (FOGG and MAKI, 2021; HELAN and ANBAZHAGAN, 2021; TANG *et al.*, 2020). However, students did not accept the model, according to Guessabi (2021), in an Algeria class. The students preferred the face-to-face classes. Thus, it is essential to assess the students' perception and performance to determine whether there has been an improvement in the learning process and whether the flipped classroom method is viable for that study population.

Considering the teaching limitations due to the Covid pandemic and the need to implement new teaching models to increase student engagement, this study aims to describe a flipped classroom design that had been applied to Food Microbiology learning during the Covid-19 pandemic. The investigation evaluates de the acceptance of the flipped classroom methodology by undergraduate students and analyzes their perception of its contributions to learning and academic performance in the Food Microbiology study.

2 | THE FLIPPED CLASSROOM IN THE FOOD MICROBIOLOGY LEARNING

2.1 Discipline conduction before the Covid-19 pandemic: the traditional classroom

The Food Microbiology discipline from the Food Engineering course at a Brazilian public university comprises four credits per week over a 15-week semester. In the traditional classroom, half of the credits were used for in-person teacher exposition of the theoretical content and the other two credits were applied for practical experiences. The theoretical classes were held in a university classroom where the responsible professor taught the academic program, i.e., the general and specific microbiology principles, and the practical classes were held in the laboratory, to introduce the experimental methods used for the identification of microorganisms. Thus, practical experience corroborated theoretical knowledge.

2.2 Discipline conduction changes due to the Covid-19 pandemic: Flipped Classroom design

As of March 12, 2020, the WHO director-general decreed the Covid-19 pandemic (WHO, 2020). Thus, the Food Engineering subject was taught remotely in the second half of 2020, with 35 students over 18 years old in the online class.

2.3 Theoretical classes

The theoretical classes were carried out in two different parts: synchronous and asynchronous. The synchronous classes were recorded for later availability to students through the digital Google® classroom platform. For asynchronous flipped classes, the video classes were made available at the Google® classroom platform one week in advance,

along with questions for further discussion. At the correct class time, a meeting was held, and the students' doubts regarding the topic addressed were solved.

2.3.1 Practical classes

The practical classes consisted of three different activities: video classes, case study presentations, and content for the population through social media posts. Videos were made to present the microbiological techniques of analysis of the main microorganisms in food. They consisted of an introduction, a summary of both theoretical classes for assimilation of the content, and laboratory methods with photos and educational videos showing plating analysis, biochemical tests, gram staining, and other tests relevant to both bacteria and fungi analyses. For the case studies concerning food spoilage microorganisms, real cases were presented about sporulated and non-sporulated bacteria, yeasts, and filamentous fungi that may or may not cause foodborne illness. Students were asked to report the possible causative agent of foodborne spoilage/disease and the potential source of contamination. The last activity proposed was to present banners social media posts, and the Instagram® platform was chosen to this end. The activity was developed with the concepts learned in class using creative and straightforward language to inform society about ways to reduce the risks of food contamination.

3 | METHODOLOGY

At the end of the course (January 31, 2021), students received the Informed Consent Form (ICF) along with a survey containing 12 questions, answered using a 3, 4 or 5-point rating system. A maximum of two e-mails requesting to fill out the form were sent, and students that agreed to participate were only allowed to respond after signing the ICF. The document aimed to assess the students' perspectives on remote education and their acceptance regarding the methodologies used in the course in the second half of 2020. After filling out the questionnaire, students received a copy of the informed consent form and their responses via the e-mail provided. The name or any other possible identification of the participant was not disclosed. Out of 35 students, 17 answered the questionnaire.

1) Were the discipline objectives clearly presented? () Never () Rarely () Sometimes () Often () Always
2) Is the discipline relevant to your qualification? How relevant is this discipline for your formation as a food engineer? () Very low () Low () Reasonable () High () Very high
3) Has the proposed program been fully completed? () No () Maybe () Yes
4) Was the content distribution throughout the course adequate? () No () Maybe () Yes
5) The teaching material provided or quoted was: () Bad () Poor () Good () Excellent
6) Were the remote laboratory classes adequate? () Never () Rarely () Sometimes () Often () Always
7) In comparison with your previous experience at laboratory classes in site, this remote experience was: () Bad () Poor () Good () Excellent
8) Regarding the recorded classes, questionnaires, and further discussion, how would you grade them concerning your learning through this experience: () Bad () Poor () Good () Excellent () Not applicable
9) About the classes held synchronously, how would you grade them concerning your learning through this experience () Bad () Poor () Good () Excellent () Not applicable
10) Regarding the resolution and discussion of case studies, how would you grade them concerning your learning through this experience: () Bad () Poor () Good () Excellent
11) What did you think about the preparation of videos for dissemination to society? () Bad () Poor () Good () Excellent
12) In relation to your learning, the activity of preparing the videos was: () Bad () Poor () Good () Excellent
13) In general terms, you considered the discipline () Bad () Poor () Good () Excellent
14) How do you rate your performance in relation to classes and activities? () Bad () Poor () Good () Excellent

Table 1. Perception of undergraduates' Flipped Classroom on Food Microbiology learning

Source: the authors

4 | RESULTS AND DISCUSSION

In addition to assessing the students' perception on the flipped classroom during the pandemic, this study also evaluated the curriculum and the food microbiology importance for the Food Engineering course during the transition to distance learning. Curricular evaluation is critical, as it helps students understand the importance of the discipline in the curricular organization and directly impacts their motivation (TINTO, 2017; ZEPKE, 2015).

Students were asked to evaluate the importance of the Food Microbiology discipline, and 94% considered it very important or relevant for their formation (Figure 1). This

discipline is essential for the Food Engineering course since it is applicable for almost all food procedures and production.

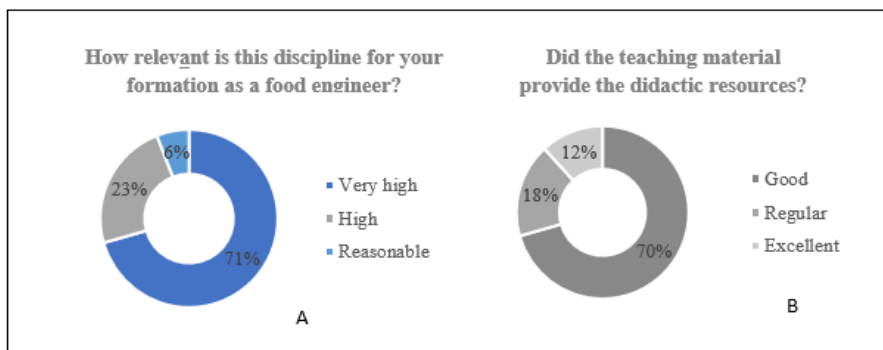


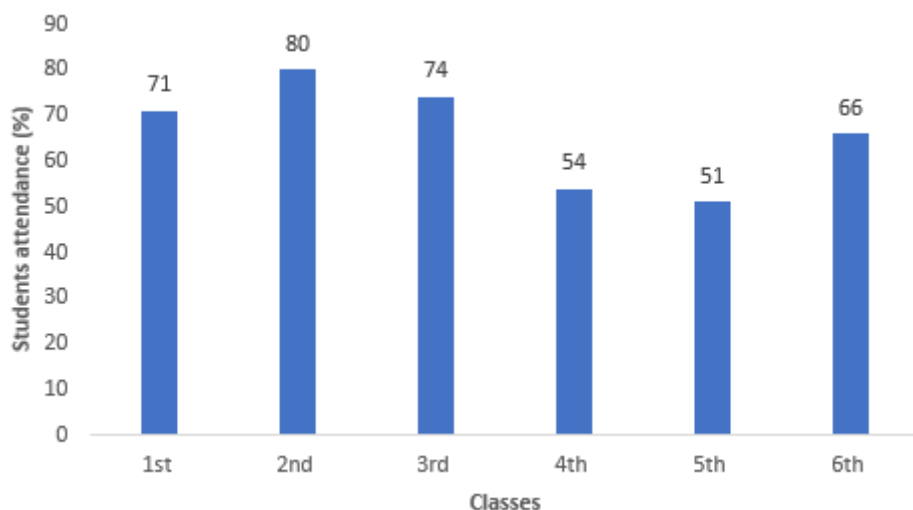
Figure 1 - Questionnaire results. "How relevant is this discipline for your formation as a food engineer" (A) and "Did the teaching material provide the didactic resources?" (B)

Source: the authors

The students' positive perception of the discipline directly affects their academic performance and whether they will remain in the course or drop out. These effects can be observed since students' motivation, effort, and engagement are affected by their task assessment. In situations where content or discipline is valued, there is an expectation of more outstanding dedication, even in the face of the challenges that arise, consequently having positive learning implications (TINTO 1997, 2017; ZEPKE, 2015). Students need to judge the relevance of the discipline content to be motivated by the proposed task and, thus, get involved with it, since little effort can be expended after an activity being perceived as irrelevant (FRICK, 2009). The importance of the curriculum is also verified through these participants' positive evaluation of the didactic resources used in the disciplines (FRICK, 2009). Specifically, 70% of university students considered that the teaching materials were good, and 12% described them as excellent for Food Microbiology. Favorable evaluations in such aspects help perceive the curriculum relevance for the students' professional development (TINTO, 2017).

Since a positive perception impacts students' engagement with the task, this study described the university students' engagement with the Food Microbiology discipline, measured through their presence in the synchronous meetings. Figure 2 shows a decrease in class attendance, with a sharper decline in the fourth and fifth meetings, followed by a subsequent attendance increase in synchronous activities. The transition from face-to-face to remote teaching changed the characteristics of the pedagogical relationship and intensified the work of both professor and students, which resulted in emotional exhaustion and illness. Such factors may help explain the decline in the presence of students in

synchronous encounters (KECOJEVIC, 2020; PELOSO, 2020; SARAIVA, 2020).



GRAPHIC 1. Students' attendance (%) at each Food Microbiology class

Source: the authors

Recent research has shown a decrease in motivation and engagement with academic activities in remote teaching compared to face-to-face teaching (PACION, 2020). The attendance drop-in simultaneous meetings should consider the access to higher education of economically disadvantaged young people. Although the university where this investigation was conducted offered equipment and internet access to students who did not have such resources, we must consider that social inequalities also have digital implications such as a large number of households not having internet access (REIS, 2020). Thus, the resources, even if made available to students by the university, might be shared with other family members, which makes their presence in all synchronous meetings unfeasible.

The questionnaire also collected data on teaching conditions considering that these affect the students' relationship with the discipline. Investigations with Brazilian students, including those involving university students, indicate that the pedagogical decisions made by the professor, such as the teaching objectives, the organization of the content, the procedures and teaching activities, as well as the assessment procedures, affects the students' relationship with the object of knowledge, which can motivate them and, consequently, make them play a more active role in learning (FIGUEIREDO and LEITE, 2019; LEITE, 2012).

As shown in Figure 3A, 88% of the students considered that the discipline objectives were always or almost always presented clearly. It is prudent to recognize that the choice of

teaching objectives is not neutral but reflects the educator's values and beliefs and intention to dialogue with more critical proposals (LEITE, 2012). The importance of establishing objectives and sharing them with students lies in the construction of an educational practice that goes beyond a traditional perspective, centered on the professor, and that links the teaching of Food Microbiology to the students' reality and enables them to act as agents of social change (FIGUEIREDO and LEITE, 2019, LEITE, 2012).

The organization of the Food Microbiology discipline was also investigated, and 88% of the participants evaluated that the themes presented were distributed adequately during the semester (Figure 3B). In addition, 94% of the students who answered the questionnaire considered that the proposed teaching program was fully complied with (Figure 3C). These results indicate that the pedagogical decisions made by the professor of the discipline were positively evaluated by the students, especially the logical knowledge organization to which university students are exposed, since, in teaching planning, respect for the epistemological arrangement of the knowledge area is fundamental for the apprehension of the content (LEITE, 2012). Also, the intimate relationship between teaching and learning must be considered for the sequencing of topics and their delimitation into stages. Some indications suggest the following path should start in the most straightforward steps and advance to the most complex ones (HENKLAIN and CARMO, 2013; LEITE, 2012). With the careful balance in knowledge distribution, since professors fail to display all content simultaneously, learning also occurs gradually. In this process, attention must be paid to the program fulfillment, necessary for the professor's goals to be achieved (HENKLAIN and CARMO, 2013).

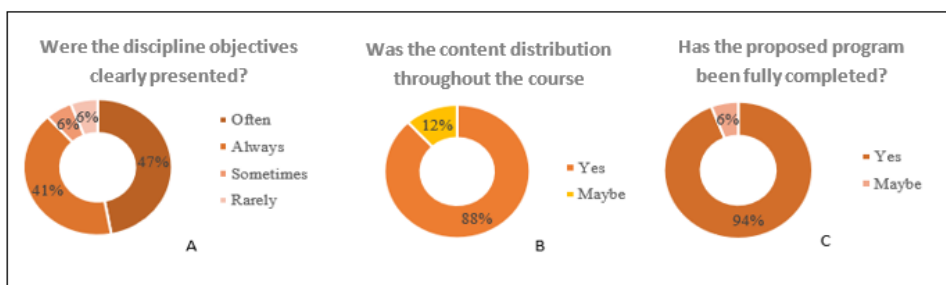


Figure 2 - Students' perception of the presentation of the discipline objectives (A), content distribution (B), and program fulfillment (C)

Source: the authors

As previously described, the Food Microbiology practical classes were impacted by the migration from face-to-face to remote teaching as one of the sanitary measures to minimize the Covid-19 pandemic. To enable practical experience mediated by digital technologies, changes in the teaching methodology, resources, and evaluative activities were necessary. In addition, this new scenario, despite the challenges imposed on professors

and students, also provided opportunities for student-centered teaching through active methodologies, which, in addition to complying with the National Curriculum Guidelines of the Undergraduate Course in Engineering, contrasts with traditional education – focused on the figure of the professor as an information spreader (BRASIL, 2019; VALENTE, 2019). Different techniques, procedures, and processes are present in the active methodologies, supporting a central role for students in their learning, among which the flipped classroom stands out (VALENTE, 2019).

The flipped classroom presupposes an integrated set of actions and procedures to engage students in activities that must be performed before and during the classroom meeting (LOVEYS and RIGGS, 2019). In the Food Microbiology discipline, short videos previously recorded were proposed, followed by questions about the video’s content, to encourage contact and problematization of the subjects covered by the discipline before class time. Subsequently, synchronous activities were mediated by the professor and monitors. In these meetings, activities for discussion and clarification of doubts were proposed, as well as the application and synthesis of the knowledge learned through case studies, as recommended by Loveys and Riggs (2019), regarding the taxonomy of educational objectives proposed by Bloom.

When asked about the flipped classroom method, 94% considered it excellent and good for their learning, as described in Figure 4A. In addition, 53% of the students assumed that the synchronous classes brought relevant contributions to knowledge, and 41% evaluated that the impact of this experience was good (Figure 4B). Regarding the presentation of the case studies and their resolution, which took place in the classroom, 65% of university students considered it an excellent activity, and 35% considered it a good exercise.

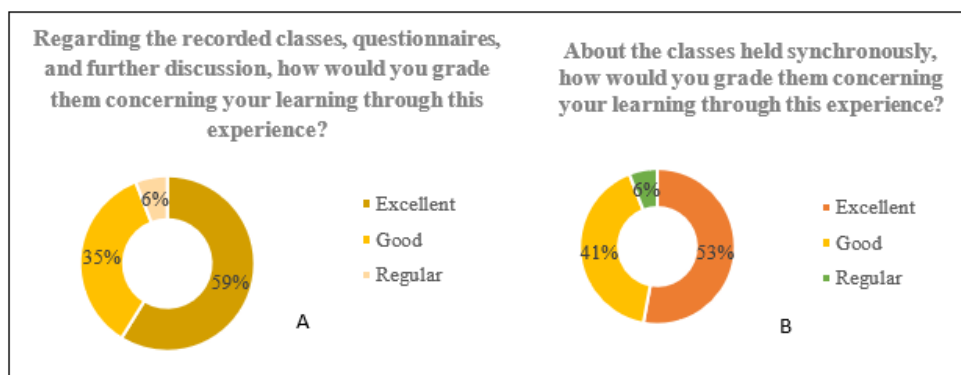


Figure 3 - Students' perception of the flipped classroom experience (A) and synchronous class (B)

Source: the authors

These results suggest the flipped classroom methodology was positively evaluated by university students, considering its contribution to their learning process. This result contradicts Guessabi's (2021) investigation, which found little adherence to this new methodology. It is important to remember that, in this discipline, the pre-classes objectives were centered on knowledge acquisition. This application dialogues with Bloom's proposal on teaching objectives, starting with exposure to a simple content, moving towards a more complex one, as presented in real study cases, which the students were supposed to solve using the knowledge acquired in class (KRATHWOHL, 2002). Thus, this application stands out from the traditional teaching proposal, based on content accumulation, being a more applied form of knowledge acquisition, consistent with students' needs. In addition, this method emphasizes the role and importance of the professor as a mediator in the knowledge construction process, expanding their practice to an action that is not centered on content communication (LEITE, 2012).

The teaching and learning process evaluation is another integral aspect of pedagogical practice, which aims to contribute to student learning by overcoming the difficulties encountered, which is also possible by constructing new pedagogical paths (LUCKESI, 2012; SORDI and LUDKE, 2009) Different evaluation activities were proposed, which distanced themselves from traditional practices, restricted to the application of tests. One of the activities was elaborating videos to disseminate the content of the discipline to society. Participants in this study were asked about their perception of the evaluative activity proposed, and 41% considered it an excellent task, 35% perceived it as a good assessment, and 24%, as regular. In addition, 70% of students said that this activity contributed to their learning, and 24% said it provided regular contributions. Although most students have a positive perception of the evaluative activity, a quarter of the participants showed reservations about the evaluation used, qualifying it as regular. Their perception of assessment is probably not far from the social construct that associates it with external exams, resulting in grades or concepts for comparison, selection, or exclusion of students (SORDI and LUDKE, 2009). We believe the main objective of evaluation practices is to review the pedagogical process and not to classify and punish students. In addition, they should not be exclusively the professor's responsibility but could incorporate practices such as self-evaluation and peer review to hold the group and the student accountable for their learning (SORDI and LUDKE, 2009).

Despite having reservations about the evaluations, 65% of the students considered that the subject was very good for their learning, and 35% considered it excellent (Figure 5A). Furthermore, 59% of students reported that they performed well in self-evaluation, 29% assess that their academic result was excellent, and 12% said they had a regular grade (Figure 5B). These results suggest the change from face-to-face to remote teaching and the flipped classroom proposition contributed to student learning and are consistent with previous investigations that found positive impacts on education and student engagement

in the Covid-19 context (FOGG and MAKI, 2021; HELAN and ANBAZHAGAN, 2021; TANG *et al.*, 2020).

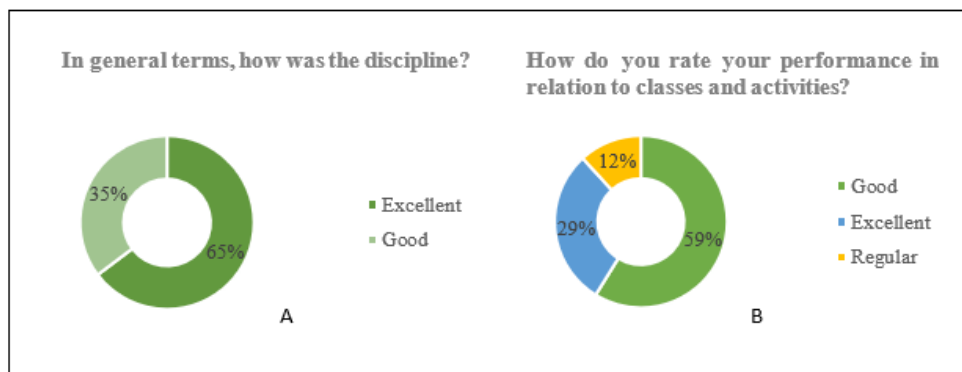


Figure 4 - Students' perception about the contributions of the discipline (A) and their self-evaluation (B)

Source: the authors

As previously discussed, the pandemic made practical laboratory classes unfeasible. The main objective of the activities carried out in the laboratory was the application of theoretical content and techniques to subsidize the formation of the undergraduates (YOUSSEF *et al.*, 2020). Remote teaching required the adaptation of different activities that once were practical components of Food Microbiology, and, in this study, it was decided to continue with the flipped classroom. Thus, the face-to-face activities taken by the university students were replaced by previous recordings of the studies, which were supposed to be watched before the synchronous classes and were later discussed. In the questionnaire made with the participants of this study, 85% of the students considered that the adjustments made were always or almost always adequate (Figure 6A). Students were also asked to compare the remote laboratory experience with other in-person laboratory activities, and 12% evaluated the new format as excellent, 41% said it was good, 35% described the adaptations, based on in-person experiences, as regular, and 12% considered the new proposal to be unfavorable (Figure 6B).

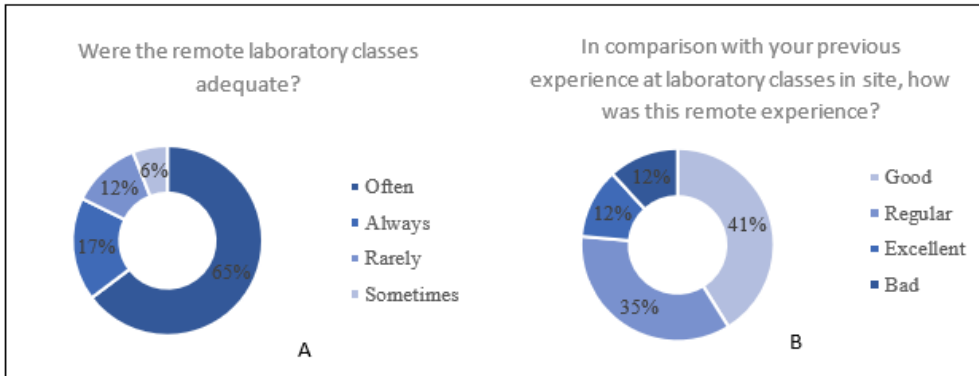


Figure 5 - Students' perception of the adequacy of remote laboratory classes (A) and laboratory class in comparison with their remote experience (B)

Source: the authors

The experience in the face-to-face laboratory is essential for students to learn the techniques and manipulate the tools for carrying out analyses, as well as to observe the isolation, the proper characteristics of colonies, biochemistry test results, identify errors when inoculating wrongly, among other important points.

Thus, the perspective of almost 50% of the students that the adaptations made were not good or excellent is understandable and reinforces the importance of practical classes in the discipline of Food Microbiology.

5 | CONCLUDING REMARKS

The use of flipped classrooms in remote teaching is in accordance with a recent review of scientific production that highlights the importance of this tool to construct active learning. A key feature of this methodology is the availability of the material in video format before classes, which helps with doubts, problem-solving, and case studies (LÓPEZ-BELMONTE *et al.*, 2021).

Thus, the students take a more active role in their learning, both before and during classes. This methodology has been driven by technological advances and digital platforms, allowing the student to pause and play the video at any time. Young people use audiovisual resources to access higher education, which can promote their engagement with the discipline (VALENTE, 2019).

There are changes in learning in the flipped classroom, where the expository class is no longer the center of the pedagogical practice and involves questioning, problem-solving, and application of content (VALENTE, 2019). Thus, the professor becomes a mediator between the student and the object of knowledge. Besides, their pedagogical decisions influence the students' retention or dropout (LEITE, 2012). The mediation of teaching, interactions, and dialogue are essential in the learning process, motivation, and

permanence of students in higher education. (ALZATE-ORTIZ *et al.*, 2020, LUCIANO-WONG and CROWE, 2019).

The students' positive evaluation regarding flipped classroom demonstrates the importance of qualified training for professors by the educational institutions, as changes in teaching practice should be grounded by consistent theoretical support (DA CUNHA, 2018). The migration from classroom teaching to the remote model meant several adjustments for professors, including mastering new technologies and creating other teaching dynamics (RONDINI *et al.*, 2020). Furthermore, in the exceptional context lived with the Covid-19 pandemic, educational decisions at Food Microbiology teaching must be trimmed by reflection and continuous improvement.

However, there were reservations about the adaptations in practical laboratory activities, as they experience in practice problematic situations encountered in theoretical classes. But the transition to remote learning was a necessary measure to minimize the impact of the Covid-19 pandemic, and is noteworthy that this measure has limits, especially regarding face-to-face interactions between teachers and students also suggesting that pedagogical adaptations are still in the development phase (FERREIRA and BARBOSA, 2020, FIOR and MARTINS, 2020).

Andrews and colleagues (2020) suggest experiment development by students at home using everyday resources for laboratory practices, in addition to recorded videos. However, the laboratory of Food Microbiology classes has several limiting factors, such as the correct preparation and disposal of the material used, which must be sterile. In addition, the microorganisms used in practical classes are mostly pathogenic or food spoilage, therefore a public health issue, and require appropriate care when handling it.

Regarding the limits of this investigation, the sample size stands out, consisting of students who voluntarily answered the questionnaire regarding the discipline assessment made available after the end of the discipline. New research could extend the sample size, collecting the answers before the end of the semester when attendance is higher.

Future research involving the flipped classroom methodology could incorporate other student engagement variables throughout the semester, such as time of participation in synchronous meetings, characteristics of interactions performed in the remote model, and other objective measures of learning and academic performance.

REFERENCES

ABBEY, Brian; HOXLEY, David. **Lab experiments in the pandemic moved online or mailed home to uni students**. 2020. Disponível em: <<https://theconversation.com/lab-experiments-in-the-pandemic-moved-online-or-mailed-home-to-uni-students-138794>>. Acesso em 21 abr. 2021.

AKÇAYIR, G.; AKÇAYIR, M. The flipped classroom: A review of its advantages and challenges. **Computer and Education**, v. 126, p. 334-345, 2018.

ALZATE-ORTIZ, F. A.; CASTAÑEDA-PATIÑO, J. C. Mediación pedagógica: Clave de una educación humanizante y transformadora. Una mirada desde la estética y la comunicación. **Revista Electrónica Educare**, v. 24, p. 1–14, 2020.

ANDREWS, J. L.; DE LOS RIOS, J. P.; RAYALURU, M.; LEE, S.; MAI, L.; SCHUSSER, A.; MAK, C. H. Experimenting with At-Home General Chemistry Laboratories during the COVID-19 Pandemic. **Journal of Chemical Education**, v. 97, p. 1887–1894, 2020.

BRASIL. Resolução nº 2, de 24 de abril de 2019. **Diretrizes Curriculares Nacionais do Curso de Graduação em Engenharia**. Brasília: MEC. 2019.

DA CUNHA, M. I. Docência na Educação Superior: a professoralidade em construção. **Educação**, v. 41, p. 6-11, 2018.

FERREIRA, L. H.; BARBOSA, A. Lições de quarentena: limites e possibilidades da atuação docente em época de isolamento social. **Práxis Educativa**, v. 15, p. 1–24, 2020.

FIGUEIREDO, A. P. S.; LEITE, S. A. da S. Afetividade e ensino: marcas de dois professores inesquecíveis da área da Matemática. **Revista Docência Do Ensino Superior**, v. 9, p. 1–17, 2019.

FIOR, C. A.; MARTINS, M. J. A docência universitária no contexto de pandemia e o ingresso no ensino superior. **Revista Docência Do Ensino Superior**, v. 10, p. 1–20, 2020.

FOGG, K.; MAKI, S. A remote flipped classroom approach to teaching introductory biomedical engineering during COVID-19. **Biomedical Engineering Education**, v. 1, p. 3-9, 2021.

FRICK, T.; CHADHA, R.; WATSON, C.; WANG, Y.; GREEN, P. College student perceptions of teaching and learning quality. **Educational Technology Research and Development**, v. 57, p. 705–720, 2009.

GUESSABI, F. Flipped classroom in higher education in Algeria during period of COVID-19: Challenges and difficulties. **International Journal of Linguistics, Literature and Translation**, v. 4, p. 196-202, 2021.

HELAN, C.; ANBAZHAGAN, K. Using flipped classroom technique on teaching platform during COVID-19. **Psychology and Education Journal**, v. 58, p. 5422-5430, 2021.

HENKLAIN, M. H. O.; CARMO, J. dos S. Contribuições da análise do comportamento à educação: um convite ao diálogo. **Cadernos de Pesquisa**, v. 43, p. 704–723, 2013.

KECOJEVIC, A.; BASCH, C.; SULLIVAN, M.; DAVI, N. The impact of the COVID-19 epidemic on mental health of undergraduate students in New Jersey, cross-sectional study. **Plos One**, v. 15, p. 1-16, 2020.

KRATHWOHL, D. A revision of Bloom's Taxonomy: an overview. **Heory Into Practice**, v. 41, p. 212–218, 2002.

LEITE, S. A. da S. Afetividade nas práticas pedagógicas. **Temas Em Psicologia**, v. 20, p. 355–368, 2012.

LÓPEZ-BELMONTE, J.; MORENO-GUERRERO, A. J.; LÓPEZ-NÚÑEZ, J. A.; POZO-SÁNCHEZ, S. Scientific production of flipped learning and flipped classroom in Web of Science. **Texto Livre: Linguagem e Tecnologia**, v. 14, p. 1-26, 2021.

LOVEYS, B.; RIGGS, K. Flipping the laboratory: improving student engagement and learning outcomes in second year science courses. **International Journal of Science Education**, v. 41, p. 64–79, 2019.

LUCIANO-WONG, S.; CROWE, D. Persistence and engagement among first-year Hispanic students. **Journal for Multicultural Education**, v. 13, p. 169–183, 2019.

LUCKESI, C. C.. Avaliação da Aprendizagem na escola. In: LIBÂNEO, J. C.; ALVES, N. **Temas de pedagogia: diálogos entre didática e currículo**, São Paulo, SP: Cortez, 2012. 433-451p. ISBN 978-85-249-2573-3.

PASION, R.; DIAS-OLIVEIRA, E.; CAMACHO, A.; MORAIS, C.; FRANCO, R. C. Impact of COVID-19 on undergraduate business students: a longitudinal study on academic motivation, engagement and attachment to university. **Accounting Research Journal**, v. 34, p. 1-12, 2020.

PELOSO, R. M.; FERRUZZI, F.; MORI, A. A.; CAMACHO, D. P.; FRANZIN, L. C. da S.; TESTON, A. P. M.; FREITAS, K. M. S.. Notes from the Field: Concerns of Health-Related Higher Education Students in Brazil Pertaining to Distance Learning During the Coronavirus Pandemic. **Evaluation and the Health Professions**, v. 43, p. 201–203, 2020.

REIS, D. dos S.. Coronavírus e desigualdades educacionais: reposicionando o debate. **Olhar de Professor**, v. 23, p. 1–5, 2020.

RONDINI, C. A.; PEDRO, K. M.; DUARTE, C. dos S. Pandemia da covid-19 e o ensino remoto emergencial: mudanças na prática pedagógica. **Journal for Multicultural Education**, v. 10, p. 41–57, 2020.

SARAIVA, K.; TRAVERSINI, C.; LOCKMANN, K.. A educação em tempos de COVID-19: ensino remoto e exaustão docente. **Práxis Educativa**, v. 15, p. 1–24, 2020.

SORDI, M. R. L. de; LUDKE, M.. Da avaliação da aprendizagem à avaliação institucional: aprendizagens necessárias. **Avaliação: Revista da Avaliação da Educação Superior (Campinas)**, v. 14, p. 313–336, 2009.

TANG, T.; ABUHMAID, A.; OLAIMAT, M.; OUDAT, D.; ALDHAEEBI, M.; BAMANGER, E. Efficiency of flipped classroom with online-based teaching under COVID-19. **Interactive Learning Environments**, p. 1-12, 2020.

TINTO, V. Through the Eyes of Students. **Journal of College Student Retention: Research, Theory and Practice**, v. 19, p. 254–269, 2017.

TINTO, V. Classrooms as communities: Exploring the educational character of student persistence. **Journal of Higher Education**, v. 68, p. 599–623, 1997.

TUCKER, B. **The flipped classroom**: Online instruction at home frees class time for learning. Education next. 2012. Disponível em: <<https://www.educationnext.org/the-flipped-classroom/>>. Acesso em: 5 jun. 2021.

VALENTE, J. A. Tecnologias e educação a distância no ensino superior. **Trabalho and Educação**, v. 28, p. 97–113, 2019.

YOUSSEF, M.; MCKINSTRY, E.; DUNNE, A.; BITTON, A.; BRADY, A.; JORDAN, T. Developing engaging remote laboratory activities for a nonmajors chemistry course during covid-19. **Journal of Chemical Education**, v. 97, p. 3048–3054, 2020.

ZEPKE, N. Student engagement research: thinking beyond the mainstream. **Higher Education Research and Development**, v. 34, p. 1311–1323, 2015.

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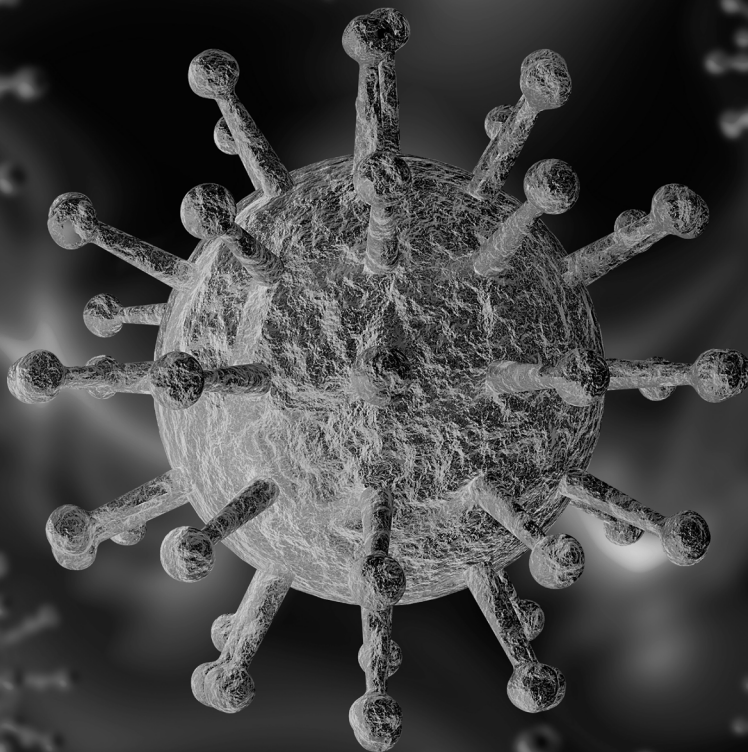
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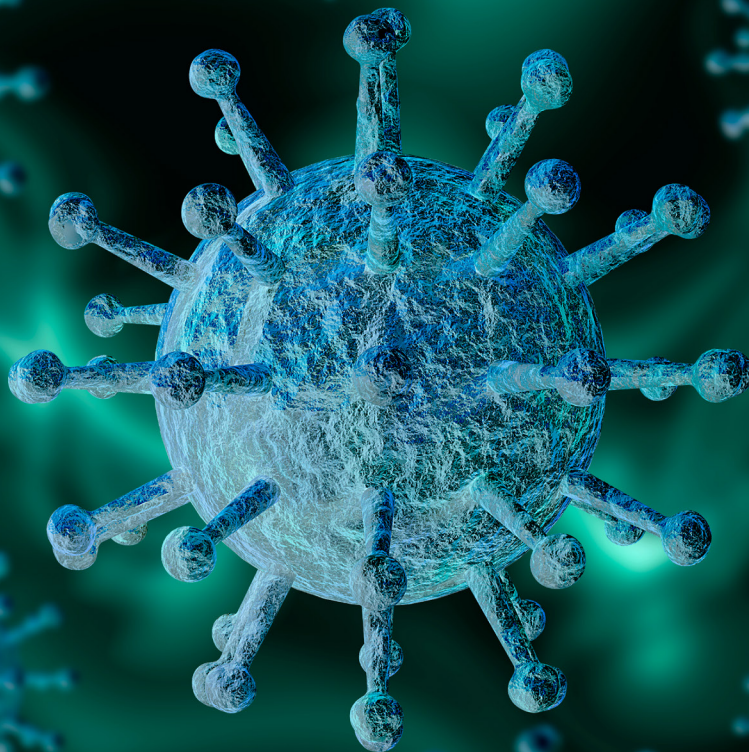
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