Remote teaching and COVID-19: perceptions of professors and students about the teaching-learning process of Chemistry and Biochemistry

Ensino remoto e COVID-19: percepções de docentes e discentes acerca do processo de ensino-aprendizagem de Química e Bioquímica

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Abstract

Since 2019 the world has witnessed the health crisis caused by the SARS-CoV-2 virus, responsible for causing COVID-19. The imposed social distancing conditions forced the university community to suspend face-to-face classes. In this context, the shift to remote learning has become a challenge due to the need not to compromise the learning process. Thus, the present study have aimed to report the experience of academics and professors facing remote classes in the curricular components of Chemistry and Biochemistry in different undergraduate courses. The present study have adopted a qualitative approach that is characterized as descriptive. The research was carried out in 3 different campuses of a Federal Public University in the state of Rio Grande do Sul (RS), and the research instrument consisted of online questionnaires intended for teachers and students. The results show the perception of students and professors on the restructuring of curricular components, perception of learning, perception of remote teaching and the use of technologies, and professors’ perception on hybrid learning, which is considered a good format for the demands of contemporary society. Through the results obtained, it can be concluded that remote teaching provided changes and reflections on teaching practice, potentially significant learning due to new skills and development of students’ autonomy.

Keywords: Technologies; Biochemistry Teaching; Chemistry Teaching.

Resumo

Desde 2019, o mundo presencia a crise de saúde causada pelo vírus SARS-CoV-2, responsável por causar a COVID-19. As condições de distanciamento social impostas obrigaram a comunidade universitária a suspender as aulas presenciais. Nesse contexto, a mudança para o aprendizado remoto tornou-se um desafio devido à necessidade de não comprometer o processo de aprendizagem. Assim, o presente estudo teve como objetivo relatar a experiência de acadêmicos e professores frente a aulas remotas nos componentes curriculares de Química e Bioquímica em diferentes cursos de graduação. O presente estudo adotou uma abordagem qualitativa e caracterizada como descritiva. A pesquisa foi realizada em 3 diferentes campi de uma Universidade Federal do estado do Rio Grande do Sul (RS) e o instrumento de pesquisa consistiu em questionários online destinados aos docentes e discentes. Os resultados mostram a percepção dos discentes e docentes acerca da reestruturação das componentes curriculares, percepção da aprendizagem, percepção sobre o ensino remoto e uso de tecnologias e percepção docente sobre o ensino híbrido, este sendo considerado um bom formato para as demandas da sociedade atual. Por meio dos resultados obtidos, pode-se concluir que o ensino remoto proporcionou mudanças e reflexões quanto à prática docente, aprendizagens potencialmente significativas devido a novas habilidades e desenvolvimento da autonomia dos estudantes.

Palavras-chave: Tecnologias; Ensino de Bioquímica; Ensino de Química.
1 Introduction

Since the year 2020 the world has been experiencing the COVID-19 pandemic, caused by the SARS-CoV-2 virus (Coronavirus). As a way of controlling the spread of the virus, health bodies recommended that non-pharmacological preventive measures should be adopted, such as the use of mask, alcohol gel, and social distancing [1]. With the implementation of social distancing, face-to-face classes had to be suspended, and in order to continue teaching, Higher Education Institutions (HEIs) were forced to adopt online teaching methods, called Remote Teaching (RT). However, the implementation of RT at the first moment was carried out on an emergency basis, without any planning, and the practices and methodologies established in face-to-face teaching, in most cases, were just transferred to online teaching [2,3].

Online teaching is a challenging task for teachers due to their lack of experience, training and technological support [4]. Knowing how to format content for online mode, having a stable technological infrastructure and receiving adequate institutional support are the pillars for successful online learning. However, many higher education institutions have found difficult to implement sophisticated learning management systems due to the large financial and technical implications [5].

There is still confusion regarding the definition of terms such as RT, Distance Learning (DL) and Blended Learning (BL), which are often used synonymously. However, there are conceptual and practical differences between them: DL is a teaching modality with online activities and its materials and application are fully planned for the virtual environment; on the other hand, RT was the way found to keep education alive with all offline and online resources available in times of crisis [6]; still, BL is a teaching modality in which face-to-face activities are often combined with technology-mediated activities for more active learning in face-to-face classes [7].

Currently, digital learning technologies, the search for innovations and the use of alternative learning models have been used in the most diverse areas of learning [5]. However, even today, higher education in Brazil, for the most part, lacks innovation and the traditional method of teaching is still used through face-to-face classes. Therefore, it is evident that in this country teachers and students previously used to face-to-face teaching had to reinvent themselves, as they were not prepared or trained for the changes that occurred during the COVID-19 pandemic.

Given this scenario, discussions about the different strategies and approaches adopted by teachers and the ability of students to adapt their learning to this format are
even more important. In addition, online strategies are not limited to focusing only on approaches related to theory, but also on other academic demands, such as possible practical laboratory classes [8]. In teaching curricular components such as Chemistry and Biochemistry, practical classes are widely used by teachers [9] in order to provide a more contextualized teaching and provide practical subsidies to foster the construction of knowledge [10]. However, given the need for social distancing, one of the challenges to be considered is how to maintain the offer of practical activities.

In fact, the pandemic scenario has brought new and old reflections and concerns to the educational field. Given the above, it is necessary to recognize the perceptions of higher education academics and professors about their experiences with RT, since this sudden change in the usual modus operandi have contributed to important changes in teaching practice and in learning processes. Thus, the present study have aimed to report the experience of academics and professors facing remote classes in the Chemistry and Biochemistry curriculum components in different undergraduate courses.

2 Methods

2.1 Research characterization

The present study have adopted a qualitative approach that is characterized as descriptive [11]. Qualitative research is an unstructured research methodology, based on small samples that provide insights and understanding of the problem context [12]. This research was carried out on 3 campuses of a Federal Public University of the State of Rio Grande do Sul – Brazil, between May and August 2021 and the semester period in force at the time of data collection (2020/2).

2.2 Characterization of the participants

The research participants were 10 higher education professors who teach in the curricular components of Chemistry and/or Biochemistry, and 40 students of these curricular components of different undergraduate courses (Pharmacy, Food Science and Technology, Agronomy, Natural Sciences, Nutrition, Biological Sciences, Cartographic Engineering and Surveying, and Interdisciplinary Science and Technology). Participants are from different campuses of this researched federal university in southern Brazil.

2.3 Data collection instrument

The research instrument consisted of an online questionnaire. The invitation to
participate in the research was sent to the e-mail of the professors and the students received the invitation to participate by the institutional e-mail that was sent by the coordinators of the campuses. The questionnaires for both teachers and students were composed of open and closed questions. The questions were related to academic characteristics; satisfaction with remote teaching, investigation of teaching methodologies; assessment of students' perception of their own learning, students' perception of the use of Digital Technologies (DT) in higher education. For the professors, questions were asked about the opportunities and limitations of remote teaching, assessment of the difficulties in adapting curricular components to remote teaching, professors' perception of the use of DT in higher education, as well as their perceptions about Blended Learning.

2.4 Method of analysis

Discursive Textual Analysis was used [13] as a method of analysis. The entire process took place through the following analysis protocol: Unitarization: Organization of the material; Floating reading of all material individually; Identification of units of meaning. Categorization: the initial categories were grouped by similarity in a first approximation level; Other levels of categorization occurred in an interpretive movement. Metatext Construction: Communicating new understandings of analysis data. The data from this work are displayed in the form of frames, fragments of participants' responses, graphs and word clouds.

2.5 Ethical aspects

The present work follows the indications of CONEP, as indicated in the Sole Paragraph: The following will not be registered or evaluated by the CEP/CONEP system: I – public opinion poll with unidentified participants and VIII – activity carried out with the exclusive purpose of education, teaching or training not for scientific research purposes, for undergraduate students, for technical courses, or for professionals in specialization.

3 Results and discussion

After the execution of the protocol for discursive textual analysis, five different categories were determined: Characterization of Participants, Restructuring of Curricular Components, Perception of Learning, Perception of Remote Teaching and Use of Technologies, and Teachers' Perception of Blended Learning.
3.1 Characterization of the participants

The first questions of the questionnaires were intended to establish the characterization of the participants, with questions regarding gender, the curricular component that professors teach and students attended at the time of application of the questionnaire, as well as the undergraduate course of the students. These data can be seen in Frames 1 and 2.

**Frame 1. Characterization of the participating teachers.**

<table>
<thead>
<tr>
<th>Genre</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40%</td>
<td>60%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curricular component</th>
<th>Chemistry</th>
<th>Biochemistry</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40%</td>
<td>50%</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Frame 2. Characterization of participating students.**

<table>
<thead>
<tr>
<th>Genre</th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td></td>
<td>30%</td>
<td>70%</td>
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<table>
<thead>
<tr>
<th>Curricular component</th>
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<th>Biochemistry</th>
<th>Both</th>
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<tr>
<td></td>
<td>50%</td>
<td>10%</td>
<td>40%</td>
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<table>
<thead>
<tr>
<th>Graduation course</th>
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<tbody>
<tr>
<td>Pharmacy</td>
</tr>
<tr>
<td>Food Science and Technology</td>
</tr>
<tr>
<td>Natural Sciences</td>
</tr>
<tr>
<td>Agronomy</td>
</tr>
<tr>
<td>Nutrition</td>
</tr>
<tr>
<td>Biological Sciences</td>
</tr>
<tr>
<td>Cartographic and Surveying Engineering</td>
</tr>
<tr>
<td>Interdisciplinary in Science and Technology</td>
</tr>
</tbody>
</table>

3.2 Restructuring of Curricular Components

With the need to continue academic activities through the RT, teachers were asked “How did the classes take place through remote teaching?” Classes took place synchronously and asynchronously, using different tools for virtual encounters and the main tools used and mentioned by teachers are presented in a word cloud format (Figure 1).
Another aspect raised was in relation to the adaptation of teachers and students to RT, since in the literature this is a widely reported and discussed aspect as a factor that brings difficulties with online teaching. In relation to this aspect, teachers and students were asked: “On a scale from 1 (I did not adapt) to 5 (Totally adapted) what is your level of adaptation with remote teaching?” In this question, the Likert Scale was used in order to measure the level of adaptation of teachers and students, as shown in Figures 2 and 3.

![Figure 2. Scale of adaptation of teachers to remote teaching](image)

![Figure 3. Scale of adaptation of students with remote teaching](image)
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Professors and students showed high levels of adaptation with the RT but, a difference can be seen in the rates of them, in which students showed lower levels compared to professors. Several aspects may have interfered in this difference, from lack of familiarity with the digital tools used by professors, not having the habit of studying online, not having a quality internet or even adequate equipment. In addition, the lack of interaction may also have been a factor that negatively affected the adaptation of these students.

Another factor raised was the duration of classes, about what the professors were asked: “Compared to face-to-face classes, have there been changes in duration of classes during the pandemic?” 90% of teachers answered that yes, there was a change in the duration of classes during the pandemic.

For those professors who reported changes in the duration of classes, another question was asked: “Why was this change necessary?” They reported numerous different motivations that led them to change the total time of synchronous classes, these data are presented in Frame 3.

**Frame 3. Reasons why there was a change in the duration of classes**

<table>
<thead>
<tr>
<th>Reason</th>
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<tbody>
<tr>
<td>“I don’t need all the time anymore, it’s possible to pass the content in smarter ways than just the teacher talking and the students listening”.</td>
</tr>
<tr>
<td>“Because classes demand less time with students as much as their attention and the need and quality of internet networks”.</td>
</tr>
<tr>
<td>“In fact, the duration of the synchronous class is shortened, but they continued to work on course activities offline.”.</td>
</tr>
<tr>
<td>“The synchronous activities were reduced, due to the fact that in very long classes, the student loses focus, there is a lot of dispersion and loss of performance”.</td>
</tr>
<tr>
<td>“There was a decrease in the duration of classes to prevent them from becoming monotonous and tiring”.</td>
</tr>
<tr>
<td>“Difficulties in keeping academics connected and interested in the content”.</td>
</tr>
</tbody>
</table>
| “Because classes get very tiring when they are very long. They get tiring both for me and for the students. It is even more difficult to maintain concentration in very long classes”.

Another question that was asked to the professors was about the teaching methodologies. They were asked: "Compared to face-to-face classes, have there been changes in the teaching methodologies used at this time of a pandemic?" 90% of teachers reported that they changed teaching methodologies during the RT period. In addition, the same questioning was carried out to the students of these curricular components, to verify if they had noticed changes in the teaching methodologies used by teachers during the pandemic compared to face-to-face teaching. 80% of the 40 participating students reported noticing changes in the methodologies used by the professors when compared to the moment before the pandemic.

As changes in the teaching methodologies used were reported, teachers were also asked “What were the most used teaching methodologies during the pandemic?” These
methodologies are shown in Figure 4.

![Debates, E-mail, Video lessons, Expository-dialogued classes, Seminars, Support exercises, Games](image)

**Figure 4.** The main teaching methodologies used during the pandemic

In this pandemic, it became evident that the main challenge faced by everyone was the ability to adapt. Faculty had to adapt their classes, learning activities and assessment strategies to the remote learning modality in order to help students achieve learning outcomes while accommodating their individual circumstances. However, even though all the necessary changes that took place were a huge challenge, pedagogical solutions in atypical situations can be lasting, thus favoring the resolution of problems and paradigms that until then seemed insurmountable [2].

From the didactic point of view, the challenges for the teacher in the RT are the same as in face-to-face teaching, where the teacher needs to plan the content, establish the learning objectives, propose activities and carry out the evaluation of the student's learning, however, now in a virtual environment [14]. When planning online activities, aspects such as: Student communication (synchronous or asynchronous); the use of DT as a support for teaching and learning, and planning the time management of actions [2].

In this study, the need to readjust the classes, the workload, the teaching methodologies, as well as the assessment of learning for the new format, became evident. However, even in face-to-face teaching, all these factors are always a challenge for professors who teach curricular components with theoretical and practical workload. Besides, now, in the context of RT, these challenges have become even bigger and more challenging.

One of the changes reported by professors and students was regarding the teaching methodologies used during the RT period, which are different from face-to-face teaching. The use of more active methodologies was evidenced, which, unlike traditional teaching, has the student as the main agent responsible for their learning, favoring their autonomy and the teacher as a facilitator of this, generating opportunities for
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problematization [15]. The reasons related to active learning constitute actions and operations that enable students to develop thinking through reflection and collective analysis [16].

A fact that could be observed in the Figure 4 and that is interesting to highlight is that only 40% of the responding teachers mentioned teaching methodologies, such as lecture-dialogued classes, seminars and gamification. The other professors (60%) cited teaching resources in their responses, such as Jamboard, Padlet, among others. These data are interesting because they show that even for higher education professors there is still confusion regarding terms and knowledge related to didactics.

Even today, in most postgraduate programs, little appreciation is given to pedagogical training, whose meritocracy has been based on scientific production [17]. In short, graduate students (future professors) develop theoretical and instrumental knowledge related to research, which is an evaluation criterion for the progression of the teaching career [18].

These aspects mentioned above generate unprepared university professors and even without knowledge about the teaching and learning process. Thus, professors end up not knowing their role as mediators and facilitators of the learning process, keeping them away from undergraduate teaching activities [18]. Therefore, the need to rethink higher education teacher training is highlighted, which should be part of institutional policies and involve the subjects themselves in this process of reflection, in order to culminate in the development of strategies that promote the improvement of the quality of the teaching and learning of future professionals in training [19].

Specialized pedagogical training will not only be able to contribute to changes in the knowledge and professional action of teachers, but will also allow to bring the teaching aspect of academic work to an equal place with the other components that characterize the profession. In addition, it seems essential to broaden the training and professional learning practices of individual initiative, but also to increase the role of institutions in this process, as it is not enough to gather individual wills to make relevant, consistent and lasting innovations. Therefore, it is of paramount importance to promote and sustain institutional processes of change and innovation that rely on the adhesion of teachers and that are a factor that enhances it [20].

The evaluation process was another aspect investigated, for which the professors were asked “How did the evaluation process take place?” And, as well as the duration of classes and teaching methodologies that were changed due to the RT, the evaluation process also underwent changes according to most of the participating professors. In this
context, 30% of them maintained the system of written tests as an assessment method, while 70% reported changes in the ways of assessing student learning. The main assessment methods used by teachers during remote teaching are shown in Figure 5.

![Figure 5. Main assessment methods used during the pandemic](image)

In the evaluation process, the quality of the dissemination of knowledge and the learning process must be taken into account. In traditional and face-to-face assessment methods, the test is the main assessment strategy, especially the theoretical test. Literature shows that this tool is usually used to classify students and not to assess established theoretical and practical knowledge [21].

The evaluation process needs to be procedural and formative for inclusion, autonomy, dialogue and collective reflections [22]. Assessment should be a permanent activity, inseparable from the teaching-learning dynamics, following the progress of students and recognizing their difficulties in intervening with sensitivity and with the participation of all those involved. Thus, the instruments for monitoring the teaching-learning process must be built thinking about overcoming the traditional model, which prioritizes the simple verification of accumulated contents aimed at the theoretical field, being more comprehensive and oriented to all its aspects, including the own program and teaching activity [23].

In this study, it was evidenced that some professors realized that the evaluation needs to be continuous and diversified, both in methodologies and in tools. The RT provided the use of several technological resources that helped this process. Therefore, professors need a more critical and reflective look to assess students in the context of RT, taking into account the qualitative and training aspects to the detriment of quantitative aspects, since traditional assessments no longer have space in this training context.

### 3.3 Learning Perception

Concern about student learning is something that has always occurred, even before
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the RT period. However, due to all the unknowns regarding this new teaching model and all its particularities, learning is one of the main current concerns. In this regard, the teachers were asked “Do you believe that remote teaching has/will brought any harm to student learning?” About this, 30% of professors believe so, that remote teaching will harm students’ learning, while 20% believe not. The other 50% of them believe that there are variables that may have affected learning during this time. The main variables mentioned by the professors are shown in Figure 6.

![Main variables cited by professors that can affect student learning during the pandemic](image)

In fact, not all of them have structured and well-equipped spaces for carrying out these works. Like the professors, the students also had to adapt their home environments to continue their academic routine, and sometimes these environments are shared by other family members, which can harm their studies. In addition, not only are physical environments shared, but the equipment as well, and a single computer can fulfill all family members in their demands. These difficulties once again expose the social and structural inequalities that hamper the promotion of equality in the educational process.

The internet, a factor highly highlighted by the professors, although it is essential at this moment, must be taken into account in the planning of remote classes is the possibility of access to the internet by the students. The last Continuous National Household Sample Survey carried out in 2021 showed that access to computers, internet and broadband does not reach 80% in most states. In Rio Grande do Sul, where the HEIs evaluated in this study are located, the data show that 82% have internet at home and of these, only 60% have broadband internet [24]. Therefore, it is extremely important to research students' technological resources and needs, adapt course materials to the technology that students have, and provide tasks that teach them how to use this technology [25].

In addition to professors’ perception, the students' perception of their own academic performance while using the RT was also investigated. Students were asked “Do you believe that your academic performance has improved or worsened with the use of remote
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In this context, 26% of students reported improvement in academic performance, 41% reported worsening and 32% reported that there were aspects that improved and other aspects that worsened. The positive and negative aspects of the RT on their own academic performance reported by the students are shown in Figures 7 and 8.

This abrupt change in the teaching modality caught not only teachers, but also students by surprise; so, they needed to quickly establish new effective study habits while dealing with the changes [25]. Furthermore, although most academics are familiar with electronic equipment and digital tools, many were not yet familiar with RT platforms and interfaces. The students’ difficult adaptation to the use of these resources is understandable, after all, synchronous and asynchronous tools are useful, but the relationships established by face-to-face teaching are not yet equal [26].

It is possible to list a range of variables that may be associated with student performance, from related elements ranging from social and economic characteristics to the influence that teachers or their educational methods have. Another factor that may be

**Material accessibility**

**Active methods**

**Better understanding of contents**

**More time to study**

**Improve dialogue with professors**

**Dynamic classes**

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**Figure 7.** Students’ perception of the positive aspects of remote teaching on academic performance

**Lack of connection**

**Difficulty of interaction**

**Demotivation**

**Difficulty adapting**

**Reconcile routines**

**Activity Overload**

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**Figure 8.** Students’ perception of the negative aspects of remote teaching on academic performance

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associated with the variation in adaptation and performance of students is regarding their learning style, which may or may not be favorable for online learning [27]. The learning process is not identical for all human beings and can be classified by different styles, having individual forms and characteristics of information, feelings and behaviors in a learning situation [28].

It is evident the importance of knowing the learning methods of each student and analyzing whether they are compatible with the teaching methods applied at graduation. This is because, when the teaching in which the student is inserted is different from their learning style, there is a need for teaching planning in order to make them have more interest in studies [28]. This issue would facilitate the construction of knowledge, since considering the individual characteristics of students, they would have a better performance in graduation, and probably in the future profession [27].

Regarding the practical classes, these took place by video classes recorded by the professors or by online practical classes carried out in the laboratories by them. However, the absence of practical classes or the realization of these through different means of classroom teaching is a variable often reported by professors as a possible cause of damage to students' learning. This perception of the professors can be seen in the excerpts of the answers presented in Frame 4.

Frame 4. Professor perception in relation to losses in students' learning.

"I believe that regardless of the way of teaching, good students will always stand out and the "bad" ones will always be bad, or rather, they will not be interested in the content, whether in person or remotely. In this sense, I can only point out here the issue of practical classes, which in fact can cause some harm to students, especially practical classes such as chemistry, physics and related areas".

“Our academics do not present self-taught study behavior, harming their learning. In addition, the lack of experimental practices in the physical laboratory causes great harm to learning”.

“One of my main fears, as I teach many practical components, is that graduates end up not using other spaces for the development of practical activities, because if they do not feel confident to use a laboratory”.

In the disciplines of Chemistry and Biochemistry, it is common to have a specific workload for the practical class. This appreciation of experimentation stems from the popularization of the idea that the methods used in class should mobilize student participation, thus differing from traditional teaching in which they remain passive. Therefore, experimentation, in this context, would be a good way to stimulate their mobilization [29,30].

Although encouraging student participation is extremely valuable, it is necessary to emphasize that the term “active method” refers to students' mental activity. Therefore, these activities must be carried out through questions and solutions and not through the mere manipulation of objects and reagents within a laboratory. Thus, the activities that
mobilize students, called active activities, do not depend on the place where they occur [30].

Having research and laboratory experience and developing communication skills are necessary factors for academics in order to prepare them for future job market opportunities [31]. With this new teaching configuration, the main obstacle was, without a doubt, the need to reconfigure practical classes for an online format. Before, the focus was mainly on laboratory skills, today, the pandemic has allowed the focus to be placed on other activities as important as, for example, literature review, data analysis, interpretation, presentation and writing of research reports.

3.4 Perception about remote teaching and use of digital technologies

Undoubtedly, the DTs are being the protagonists in this moment of RT, because it was through them that it was possible to continue teaching. On this issue, teachers and students were asked “Do you consider technologies good teaching aids?” 100% of teachers responded that technologies are good teaching aid tools. As for the students, 92% believe that technologies are good tools to aid teaching and 8% believe that they are not. Another question raised to the teachers was “With the return of face-to-face classes, do you intend to continue using technologies in your classes?” All participating teachers (100%) intend to continue using the technologies after the return of face-to-face classes.

The use of technology in the educational field facilitated access to information for both professors and students, as they promote greater autonomy and independence of students, as well as favoring student participation in an interactive way [32,33]. RT is an educational modality that provided exchanges of learning and construction of knowledge between people in different places, regions and countries during the pandemic [34]. Therefore, the issue of distance is not an obstacle to producing and sharing knowledge.

In short, the use of DT as a teaching tool requires both the educator and the student to adopt new postures in the face of the challenges of teaching and learning. For the educator, the challenge is to open up to new possibilities, where he is no longer the central point of information and the main protagonist of the process. On the other hand, it is up to the student, the challenge of taking the reins of their own learning, discovering the best way to learn and use the acquired knowledge [35].

In addition to DT, another very necessary and used resource at this time was the internet, as it provides a large number of didactic resources that can be used by teachers in their classes, according to their demands. There are several applications that help students formulate and test hypotheses about the contents taught [15]. However, after
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outlining the objectives, professors must prepare study guides to guide students in relation to the teaching material, given the possible dispersion of students if not well oriented [36].

The use of RT has brought numerous challenges for professors, both in terms of adapting classes and the need for changes in teaching methodologies, as well as in the difficulty of motivating students. However, the RT not only brought challenges to teaching, as numerous possibilities for improving teaching were possible due to this shift to remote classes. Therefore, the professors were asked “What is your perception of the possibilities and limitations of Remote Teaching?” These data are shown in Frame 5.

Frame 5. Possibilities and Limitations of remote teaching cited by teachers

<table>
<thead>
<tr>
<th>Possibilities:</th>
<th>Limitations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>“The possibilities are to increase the interest of digital native students, who are well adapted to the use of the internet, making classes more attractive”.</td>
<td>“The only limitation I consider is not to &quot;feel&quot; the students, that is, not being able to identify through their features and grimaces the doubts and questions that many have and often do not do so out of shame or another reason”.</td>
</tr>
<tr>
<td>“Numerous, since there are databases, online library, several ways to prepare activities”.</td>
<td>“Great decrease in student-teacher interaction and contact”.</td>
</tr>
<tr>
<td>“Endless possibilities, limited only by imagination as there are so many resources available”.</td>
<td>“Limitation is the impossibility of carrying out practical classes”.</td>
</tr>
<tr>
<td>“The main advantage is the (re)discovery of new ways of teaching/learning by students and teachers”.</td>
<td>“Many undergraduate students reported difficulties in accessing the internet and lack of an adequate study environment in their homes, which limited their performance”.</td>
</tr>
<tr>
<td>“Remote teaching allows the participation of academics located in different regions, as well as access to study material”.</td>
<td>“Not all students have access to quality computers and/or internet. Or when they have access, they don’t know how to use the resources”.</td>
</tr>
<tr>
<td>“I think the main advantage is quick access to information and the development of new skills (for example, producing a video forces students to seek improvement or learn to use technology)”.</td>
<td>“The limitation is the difficulty of interacting with students (especially those who were not known in face-to-face teaching)”.</td>
</tr>
<tr>
<td>“The main advantage is the (re)discovery of new ways of teaching/learning by students and teachers”.</td>
<td>“Interaction between academics and professors is impaired, as this does not always occur, different from face-to-face classes. In addition, there is a great difficulty in maintaining the interest of the academic in class, all the time”.</td>
</tr>
<tr>
<td>“Remote teaching allows the participation of academics located in different regions, as well as access to study material”.</td>
<td>“The lack of personal relationship, discussions and interaction among the group. Practical classes are also limited, it is necessary to equip students to use practical spaces such as the science laboratory, chemical”.</td>
</tr>
</tbody>
</table>

Another question asked to the professors was “Do you believe that remote teaching has positively added to your teaching career?” 90% of professors answered yes, and 10% answered no. The positive aspects highlighted by the professors can be seen in Figure 9.
There are numerous ways to learn, although individuals have similar characteristics, each student's personal way of learning (learning styles) is distinct [37]. Like students, teachers have a unique teaching style and according to their own learning style, which may or may not be favorable for their adaptation to online teaching [38]. Therefore, although teachers have their own teaching style, they must use a wide variety of teaching styles that help to align students' learning styles to achieve successful learning outcomes adapted to the new reality [39].

Teachers' ability to manage online learning can significantly affect students' learning experience [5]. Therefore, the need and importance of training faculty members in the use of active technologies and methodologies, as well as content projection and evaluation for the online format, is evident [33]. However, these issues must also be rethought and discussed for the face-to-face format, knowing the need for innovation in higher education.

Bringing new issues of practice and seeking to understand them from the perspective of theory and in practice itself allows articulating new knowledge in the construction of teaching, dialoguing with those involved in the process that surrounds training [40]. Based on this, DT has been considered an ally to teacher training, as it provides new and diverse spaces for communication and learning [41]. However, it is not enough to just insert these technologies, as it is necessary to use them in new practices, making teachers the protagonists of this training [42].

Students were also asked “Do you believe that remote teaching will bring harm or benefits to your future career?” 55% of students classified that they believe that remote teaching will bring harm and, of these, 50% cited the lack of practical classes as one of the main factors. The other 45% of students classified that they believe that RT will bring benefits to their future career and, of these, 45% mentioned that having learned new technologies is the main positive aspect.

There is still no answer as to whether the practical classes that were taught during the RT will be a point that will actually harm the students or if the format used by the
teachers did not favor learning. However, it seems that, although uncertain and not experienced in the same way by everyone, the changes may have been beneficial because they occurred in a different way to the traditional one, allowing new learning, new experiences and thus showing that the realization of practical knowledge can be carried out in a format other than within a laboratory environment. In general, even though it was a challenging period for both components of the teaching-learning process, it brought innovation to teaching, new experiences for students and teachers and showed that DT can contribute to teaching.

3.5 Professor Perception of Blended Learning

Since the RT is a strategy used on a temporary basis found for the continuity of education, there is a strand that defends the use and implementation of BL in Higher Education. In this regard, the professors were asked “Do you believe that blended learning is the projection of the future of higher education?” Of the participating professors, 80% believe that yes, the BL can be the projection for the future of Higher Education and 20% believe that it depends on the undergraduate course. Another question asked was “What is your opinion about blended learning?” The professors' opinions regarding the BL are demonstrated through excerpts from the answers, presented in Frame 6.

Frame 6. Professors' perception of blended learning

| “I believe that it is a possibility of continuing teaching and not interrupting students’ learning, mixing the synchronous with the face-to-face and thus, giving opportunity to all” |
| “For now I see that it is a very interesting path, but it still needs more time to see the result” |
| “We need to discuss and learn more about the subject, the university must invest in the training of teachers for this task” |
| “I think it is the solution to attract students to our institution, allowing students to attend classes without permanently moving to the host cities of the courses” |
| “I think that will be the trend for the next few years, totally viable” |
| “If implemented in a responsible way, it is a very powerful tool, as it provides knowledge exchange with a much broader reach than strictly face-to-face teaching” |
| “This methodology combines face-to-face and remote teaching and both have many advantages. In the pandemic, it was verified that it is possible to implement it. In this way, I believe it will remain in the post-pandemic period” |
| “It can be used in some cases. The best way to teach a curricular component and its adaptations should be evaluated” |
| “I believe it should be invested in blended learning, it can be a way to reach more students who want to acquire knowledge and cannot afford it by distance or time” |
| “I think it will be the option of the future, as it will be able to combine the positive elements of both modalities, face-to-face and return (or distance) teaching” |

Knowing that RT was an alternative used as a way of continuing education, it is now discussed whether education can permanently migrate to other teaching modalities that advocate the use of technologies such as, for example, BL. However, even today there is a lot of confusion about terms like RT, DL and BL. Although they have similarities, mainly...
because they use technologies, there are conceptual differences that need to be understood by everyone in the academic environment.

The emergency RT was a temporary alternative to the educational scenario imposed by the pandemic. This modality involves the use of alternative teaching tools that are totally remote due to the impossibility of face-to-face teaching. In addition, the RT's proposal was to offer temporary access and provide educational support quickly and reliably during an emergency crisis [2].

The DL has been used for many years in Brazil. This teaching modality provides a broader learning that occurs with the use of information and communication means and technologies, with qualified personnel, with access policies, with compatible monitoring and evaluation. In addition, it develops educational activities for students and education professionals who are in different places and times [43].

BL is a teaching model that combines online and face-to-face pedagogy and has been gaining ground in recent years. Faculty who employ hybrid pedagogies intentionally incorporate technological tools to enhance student learning and respond to a wide range of learning preferences [7]. In this bias, it is believed that BL can contribute to the personalization of teaching, as it transforms mass education into one that allows students to learn at their own pace and according to previously acquired knowledge [44].

The BL is based on a disruptive innovation, seeking to break the performance standard of the industrial teaching model. Part of this rupture presupposes that student learning has different rhythms, based on two points: on different skills and on the prior knowledge that each student has [45]. Therefore, the flexibility of this model and the focus on shared knowledge motivates the student to actively participate, interacting and making experiential associations, making them protagonists and promoting their engagement in the processes [46].

Based on data referring to professors' perception of hybrid learning, we can conclude that even though it is something new and there is a need to train teachers for its implementation, their view is quite positive. This is because BL allows students to have more productive time in the classroom, also generating greater possibilities for students from other locations. In addition, innovation in Brazilian education is something much discussed, being seen as something extremely necessary. And today, technologies make this innovation possible, providing the personalization of learning and autonomy to students. Therefore, it is believed that BL can become a valid possibility for the future of higher education in Brazil, if implemented responsibly and with a lot of planning.
4 Conclusion

Providing students with highly structured content, developing asynchronous activities and promoting active learning during synchronous meetings are undoubtedly the pillars to help students at this time. As educators, we must look to leverage these new technologies to enhance the learning experience and expand learning beyond the walls of the traditional classroom.

Thus, both theoretical and practical classes need to be planned in such a way as to provide student participation, as this is essential not only for scientific investigation, but also to promote essential skills and knowledge for the profession. And despite the lack of face-to-face interactions, RT provided the opportunity for students to materialize knowledge through other means, as well as develop their autonomy. In addition, the pedagogical skills of teachers in an online environment were reinforced mainly in terms of organizing content for better learning experiences, adapting assessments to new requirements and creating differentiated learning environments, with the help of DT.

In addition, the RT brought up the need to rethink about the pedagogical practice and how much it is necessary to leave the sameness and comfort zone. Students were able to develop more autonomy and time organization of their studies, in addition to learning about tools and different ways of learning from those prior to this pandemic period. Finally, all these changes, although they have brought challenges and some losses, have also provided new skills and reflections that have long been necessary for Education.

References


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Appendix

Questionnaire for Professors

1- Genre:
Feminine
Masculine
I prefer not to classify myself

2- In which curriculum component do you teach?
Chemistry
Biochemistry
Both

3- How did the classes take place through remote teaching?
*open question

4- On a scale from 1 (I did not adapt) to 5 (Totally adapted) what is your level of adaptation with remote teaching?
1
2
3
4
5

5- Compared to face-to-face classes, have there been changes in duration of classes during the pandemic?
Yes
No

6- If your previous answer was yes, why was this change necessary?
*open question

7- Compared to face-to-face classes, have there been changes in the teaching methodologies used at this time of a pandemic?
Yes
No

8- What were the most used teaching methodologies during the pandemic?
*open question

9- How did the evaluation process take place?
*open question

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10- Do you consider technologies good teaching support?
   Yes
   No
   Other

11- With the return of face-to-face classes, do you intend to continue using technologies in your classes?
   Yes
   No

12- Do you believe that remote teaching has/will brought any harm to student learning?
   *open question

13- What is your perception of the possibilities and limitations of Remote Teaching?
   *open question

14- Do you believe that remote teaching has positively added to your teaching career?
   Yes
   No
   Other

15- Do you believe that blended learning is the projection of the future of higher education?
   Yes
   No
   Other

16- What is your opinion about blended learning?
   *open question

Questionnaire for Students

1- Genre:
   Feminine
   Masculine
   I prefer not to classify myself

2- What is your degree course?
   *open question

3- What subject are you studying?
   Chemistry
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Biochemistry

Both

4- On a scale from 1 (I did not adapt) to 5 (Totally adapted) what is your level of adaptation with remote teaching?
1
2
3
4
5

5- Compared to face-to-face classes, have there been changes in the teaching methodologies used at this time of a pandemic?
Yes
No

6- Do you believe that your academic performance has improved or worsened with the use of remote teaching? Why?
*open question

7- Do you consider technologies good teaching support?
Yes
No
Other