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BONDS, PRACTICE, AND CHEMISTRY: EXPERIENCE REPORT AND REFLECTIONS ON POTENTIALITIES OF TEACHING-LEARNING PROCESS OF CHEMICAL TECHNICIANS IN MIDST OF THE COVID-19 PANDEMIC

MESQUITA, Iago Santos^{1*}; PAZ, Miguel Pedro Alves da¹

¹ Instituto Federal de Educação, Ciência e Tecnologia do Rio de Janeiro, Coordenação de Segurança e Administração de Ambientes Tecnológicos

* Correspondence author
e-mail: iago.mesquita@ifrj.edu.br

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ABSTRACT

This work aims to report the experience of teaching a course with practical contents in chemistry in the distance modality due to the period of isolation by the COVID-19 pandemic. The target of the course was students of the Federal Institute of Education, Science, and Technology of Rio de Janeiro (Duque de Caxias campus), who study to be technicians in the field of Chemistry. In order to do so, the importance of experimentation in professional learning is discussed, as well as the difficulty of distance learning in practical training is analyzed. Following the course format and the resources used to overcome the limitations of distance learning and help the students keep the contents in mind are introduced. Student participation was an important component in choosing some themes for the course modules. Realizing the importance of construction that understands them as active subjects in the teaching-learning process, it was possible to offer modules that touched the students reality and expanded their knowledge through comprehensive training. The themes and approaches were proposed to help them define or rethink their career through contact with different realities of the work of a technician in the field of chemistry. The report ends by analyzing how a transdisciplinary education could help students connect knowledge acquired separately and aggregate it to see reality more broadly and completely. The difficulties arising from the COVID-19 pandemic made it possible to discuss a teaching way that would lead students to participate more actively in their training and, dialectically, strengthen pedagogical praxis.

Keywords: *Distance learning, Pandemic, Education in Science, Experimental Education, Active Teaching Methodologies*

1. INTRODUCTION

Theoretical activity exists only from and in relation to practice; there is no thinking outside of human action. Consciousness and conceptions are formulated through the movement of thought, which focuses on the "world of actions" and the relationships they generate. Even if theoretical activity reframes conceptions, it transforms representations, produces theories, in none of these cases transforms reality alone. Ideas need to be transformed into actions (Kuenzer, 2017).

In this sense, Saviani (1983) highlights that education acts on the practice subjects in an indirect and mediated way. This author view distances itself from the conception that the

teaching and learning process occurs first in a theoretical way so that, finally, it is developed - a perspective often reinforced by the traditional formatting. In this context, it is appropriate to quote Dewey that "*Education is a life process; no preparation for the future life*" (Dewey, 1940, p. 6). Dewey (1940), in the conception of Experimental Education, understands that the student must be subjected to real problems. Therefore, the educational process would consist of analyzing the mechanisms of the problem, in the creation of hypotheses about the problem, and in the reflection on the solution alternatives: in the re-signification of their experiences, in short.

The principles of Experimental Education and theory-practice articulation are very clear in the training of professionals in the field of

chemistry. Moreover, these subjective ideas are even frequently performed in objects: the curricular contents are represented in practices, and theories, in glassware, reagents, and other laboratory utensils.

However, in 2020, the COVID-19 pandemic posed unthinkable challenges to humanity as a whole, mainly to education. How to think about the training process of technicians in the field of chemistry, professionals so linked to laboratory practice, in a context of *lockdown*? How to mitigate the effects of distance learning in the training of these professionals? More than that, and perhaps more essential: how to keep these students motivated? How to maintain the bonds between academic community members?

This work does not intend to exhaust these issues, which are so deep and delicate for the teaching-learning process nowadays, but rather to provide alternatives. This text is intended to be an experience report on an extracurricular course of continuous training given by the Technological Environments Safety and Administration Coordination (CoSAAT) of the Federal Institute of Education, Science, and Technology of Rio de Janeiro (Duque de Caxias *campus*) in 2021. From this report, reflections on potentialities flourish on concrete challenges of these times.

2. MATERIALS AND METHODS

With the impossibility of conducting the course in face-to-face mode, the course was offered in distance learning through synchronous meetings on the *Google Meet* platform.

During planning, topics such as reagent compatibility, laboratory safety, and waste management remained on the course menu, but with activities designed directly for the modality of training offered.

In addition, other topics were proposed aimed at specific professional fields, which could break new ground in their careers, such as chemical products inspection and control, first aid in the laboratory, the pharmacy chemical industry, among others.

2.1 Resources Examples

In the presential course, the chemical compatibility module had an activity using cards and the laboratory board to favor active teaching methodologies. This theme was approached with an interactive activity in a 3D virtual Chemical Storage Room using *Paint 3D* software (Figure 1).

Every time a reagent was placed with an incompatible one, the “technician” suffered an injury, like in a hangman game. Therefore, the target was to complete the arrangement of the stock without the technician dying. At the end of the activity, students knew the necessary conditions for safe storage.

Figure 1. Chemical Storage Room

The online laboratory safety training, with expanded time, enabled the presentation of different safety equipment and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). After topic explanation through images, videos and discussions were proposed activities to keep in mind the contents. The activities were offered within the presentation itself and through free external resources such as *wordwall.net* (Figure 2).

Figure 2. Quiz of Lab Safety Module

In addition to these, other online resources such as electronic spreadsheets with remote access and screen mirroring of specific programs and websites enabled students to observe and even use some of these programs.

3. RESULTS AND DISCUSSION:

Fifteen modules were offered during 10 months, as shown in Table 1:

Table 1. Modules and Duration

Module	Duration (h)
Chemical Compatibility	1,5
Excel applied to the field of chemistry*	1,5
Solid characterization techniques and data treatment by the Origin software	1,5
English applied to in the field of chemistry*	1,5
Laboratory Safety I and II	3
Waste Management	1,5
Chemsketch software*	1,5
Chemicals Control	1,5
Laboratory First Aid	1,5
Laboratory Equipment*	1,5
Industrial Equipment*	1,5
Experimental Planning and Data Analysis I and II	3
Creating Charts Using Spreadsheets	1,5
Organic Compounds Industrial Production	1,5
Technical Sales and Laboratory Accreditation	1,5

* Suggested by the students

The students behaved as subjects of the teaching-learning process: they participated in the course of their own volition and, without any summative assessment tool, they remained in it. Moreover, the theme of many of the modules was a suggestion by the participating students themselves. By participating in the course, they gradually take on the lead in this course: they raise doubts and possible deficiencies in their regular course, suggest topics that can help them in college entrance exams, the labor market, or even in their daily lives. Therefore, they begin to have

autonomy in their formative process.

The construction of this autonomy is linked to a less conservative and more humane education proposal. By collectivizing the curricular decision – and here it is remembered that curriculum is an instrument of power – it is understood that a formative process is distinct from that in which knowledge is organized for the individual, but that the individual empowers himself to organize his knowledge. From the theoretical perspective of Rogers (1997), the motivation for this process would be a self-fulfilling tendency of the individual to become who he is.

It is noteworthy then that the disruptions caused by the COVID-19 pandemic led to an unlikely scenario in education. In this scenario, many control tools dissociated, liquefied; time became spatialized, and the notion of the place was resignified. In this strange place, new ways of conducting the teaching-learning process abound. It is believed that here through this report, one can think of some of them.

One of the concerns was to guarantee in this process the teacher-student interaction and among the students themselves. However, it is believed that the methodology of active learning, such as the proposition of games, allowed this engagement. In many moments, a student was noticed participating in the colleague response, discussing together, even with all the limitations that a remote class can have.

It should be noted that in the group discussion, students can exchange knowledge, argue, and build something together, and, often, they can find a locus of speech to talk to their doubts and concerns. In this argument, analytical capacities and interconnections between subjects are present: in this otherness, in the encounter with the thought of others, that apprentices can actively discern their cognitive processes (Lévinas, 1993).

Another concern was the maintenance of bonds between students and with the symbolic place of school. However, the bonds maintained by the regularity of the course led to contradictions about the practices – and the thinking about practices – of the notion of space. Perrenoud (2000) clarifies that the antagonism between non-spaces and physical or symbolic spaces transcends the perception of mobility restrictions. They also become a dynamo of contradictions and constructions between the political, economic, and cultural forces that subject themselves to a territory. That is, the digital did not necessarily subtract territorialities but essentially make them

more fluid.

What kind of links are built from the perspective of the physical place? It was realized that in the course, with discussions about careers, about living the pandemic, about deciding on its formation, they became much more powerful tools in constructing these bonds with a symbolic place than with the physical place itself.

Moreover, finally, the different types of knowledge worked together with the students stand out. Some graduates reported that contents were covered later, at the beginning of their undergraduate course. Content of chemistry, such as safety, compatibility, analytical tools, and knowledge in human health, computer languages, and industry, were addressed. That is, the proposition of a curriculum is not only collectively thought out but transdisciplinary. Many of the themes from other areas were suggested by the students themselves.

This strengthens the hypothesis that when taking autonomy in building his career, the subject perceives the need to draw connections between different types of knowledge. Decompartmentalization, facing real problems and experience as a focus naturally led to a transdisciplinary approach. Thus, a chemical technician is not formed only on chemical bonds but on the bridges he builds with different knowledge permeating his work.

Therefore, it is believed that the contradictions arising from teaching in times of pandemic paths could be rethought. All the contradictions raised by the challenges imposed on the pandemic can be seen as an opportunity to think about pedagogical practice. That is a dialectical path of strengthening the *praxis* in difficult times for humanity.

4. CONCLUSIONS:

Under the adversities of the imposition of abruptly remote teaching, a training course was designed to mitigate the damages in the training of technicians in the chemistry area of the IFRJ – Duque de Caxias *campus*. However, especially in the training of these professionals, whose work is directly linked to work in laboratories, the losses could be even more worrying.

With the intention of attenuating such effects, during a liquid scenario, new paths could be thought. The contradictions imposed on this path gave rise to a dialectical process by questioning the perspectives of bonds, syllabus,

transdisciplinarity, and theoretical-practical articulation. The search for answers to these questions led to fruitful reflections for both the face-to-face and virtual teaching-learning process – that is, dialectically they fostered praxis.

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