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Organic chemistry manuscript in pandemic times

Henrique de Oliveira Prata Mendonça
Universidade Federal de São João Del Rei

Ana Carolina do Carmo Mazzinghy
Universidade Federal de São João Del Rei

Carla Mariele Silva Ribeiro
Universidade Federal de São João Del Rei

Edivam Fonseca Silva Azevedo
HSM University (Grupo Una)

Pâmela da Silva Rocha
Universidade Federal de São João Del Rei

Amauri Geral de Souza
Universidade Federal de São João Del Rei

Éric Marsalha Garcia
Universidade Federal de São João Del Rei

Hosane Aparecida Taroco
Universidade Federal de São João Del Rei

Luisa Del Carmen Barrett Reina
Universidade Federal do Mato Grosso

Corresponding author
Júlio Onésio Ferreira Melo
Universidade Federal de São João Del Rei
onesiomelo@gmail.com

Abstract. In the 1990s and 2000s, several countries underwent important and significant changes in their universities. Likewise, in Brazil, due to the implementation of several government programs, there was an expansion of higher education and made possible a greater access to graduation. At the beginning of 2020, the world was threatened by COVID-19, several restrictive measures were implemented by government and private entities to contain the spread of the disease. In this way, Brazilian educational institutions were forced to temporarily suspend their in-person activities in order to promote social distancing. They soon found themselves in the challenge of implementing teaching methodological changes to continue the activities, in an emergency and remote way, since the outbreak of the disease did not stop within months and there was no prediction of when it would occur. This study aims to evaluate the performance of students at the Federal University of São João del-Rei at the Sete Lagoas campus in the discipline of Organic Chemistry, in the Food Engineering, Agronomic Engineering, Forestry Engineering and Interdisciplinary Biosystems courses in the two semesters of 2018 with 223 students and during the two semesters of the first year of

emergency remote teaching (2020) with 337 students, drawing a parallel between them in order to raise the impacts of remote teaching for the discipline of Organic Chemistry.
Keywords: evasion and retention; remote teaching, emergency remote teaching, organic chemistry.

Introduction

In the 1990s and 2000s, several countries underwent important and significant changes in their universities. In the late 1990s, was established a deep reform process in education across the world through the World Higher Education Conference, held in Paris (Bernhein & Chaui, 2008). Therefore, respecting its characteristic history, those countries implemented reforms in their educational systems to make them more efficient in the course of the continuous technological revolution and its political, social and ethical aspects (Psacharopoulos & Patrinos, 2018; Kromydas, 2017; Mello, 1995).

Similarly, reforms also occurred in Brazil's higher education systems, which resulted in high levels of access and permanence, and the quality standardization. From 2007 on, Brazil consolidated the transformation processes of the universities, with vacancies increase in a decisive and sustainable way, with academic quality, territorial coverage and social inclusion (Brasil, 2007). This transformation is associated with economic, social and cultural changes, where the university operates by evaluating theories, practices, concepts and models, which highlights the importance of evaluating and reflecting on teaching and learning practices at the universities (Garcia, 2009).

In early 2020, the world was threatened by COVID-19, an unexpected and uncontrollable new virus (SARS-CoV2), as a counter-measure the World Health Organization (WHO) declared a worldwide pandemic (Lu et al., 2020). A variety of restrictive measures were implemented by government and private entities to contain the spread of the disease, such as social isolation, cancellation of events, closing of public places, schools, companies, and commercial establishments (Wilder-Smith & Freedman, 2020). During major crises, it is common to see a dichotomy between the economic world and the financial world, where markets were paralyzed, but the financial commitments continued uninterruptedly (Silber, 2020).

Amidst those times, Brazilian educational institutions were forced to suspend in person activities temporarily. Soon those institutions faced the challenges of implementing methodological changes in teaching to give continuity to the activities, remotely, since the disease outbreak didn't cease within months and there wasn't prediction of when it would end (Souza et al., 2021.; Júnior et al., 2021.; Campanella & Seixas-Sardinha, 2021.; Santos, 2020.; Gusso et al., 2020.; Lu et al., 2020.; Wilder-Smith & Freedman, 2020; Williames, 2001).

Differently from Online Learning (OL), which predicts a pedagogical planning based on stimulate autonomous learning methods, medium or long term, in addition to trained teachers and tutors, capacitated for such model and its virtual platforms, the Emergency Remote Teaching (ERT) imposed on the teachers, and its already used learning methods, adaptation from the in-person learning to the remote/virtual format. Consequently, teachers found themselves with the challenges of mastering digital information and communication technologies, to share with adequacy the objective knowledge needed, through videos, texts and images, and, at the same time, adapt their teaching methodology, adapting their didactic-pedagogical tools to models based on active learning methodologies, in which students become responsible for setting their own study routines, as well as their goals and objectives (Coqueiro & Souza, 2021.; Wiliames et al., 2021.; Souza et al., 2021.; Júnior et al., 2021.; Campanella & Seixas-Sardinha, 2021.; Santos, 2020.; Gusso et al., 2020).

The chemistry teaching aims to provide knowledge and comprehension of the technological and natural changes that occurs in different situations, connecting these learnings to the production systems (Brasil, 2006). Chemistry can be classified as the central science in the design of new materials, offering answers to a variety of demands through the knowledge of the properties, formation and transformation of substances (Mortimer et al., 2000). Santos et al. (2004) affirms that chemistry promotes greater interaction with the student in the learning process, awakening the comprehension of the content taught in class, linking them to the lab, practical activities and, consequently, improvement in the training process of professionals.

Traditional curricula have revealed, in most cases, that only conceptual aspects of chemistry have been taught, supported by a tendency of not relating school chemical culture with its origins or with any technological context (Taber, 2020).

Historically, the evasion and retention of university students is widely debated and analyzed and compromises all Brazilian educational institutions, specially the public universities. Several factors can affect those statistics, although the causes are not well known. It is worth mentioning that evasion promotes perceptible damage to society, such as: wasted capacity of education and training; lower production efficiency; national competitiveness loss; lack of skilled labor; and others (Silva et al., 2007).

This study aims to evaluate the Organic Chemistry student performance in the year 2018 and the first year of the emergency remote teaching (2020), drawing a parallel between them in order to raise awareness of the impacts and necessary adaptations for the implementation of remote teaching for the Organic Chemistry discipline.

Materials and Methods

The adopted methodology was based on bibliographic study of higher education in Brazil in the last two decades, with implementation of some government programs that expanded university access to students (Costa et al., 2017). A situational diagnostic of chemistry teaching for Agricultural Sciences was made, addressing difficulties of beginners, highlighting the contribution of mentoring to improve the teaching/learning process. The performance analysis of the Organic Chemistry students at the Federal University of São João *del*-Rei – Sete Lagoas campus was carried out with data from the years 2018 and 2020. 2019's data was not utilized due the head professor of the discipline departure for its post-doctorate, in order to avoid more variables in the data, it was chosen to work with the year before and the first years of the pandemic. It is worth mentioning that the teacher for the Organic Chemistry discipline in all courses on the Sete Lagoas campus is the same. The collected data was: number of Organic Chemistry students; number of approvals; grades of approved students (grades higher or equal to 60); number of retained students (grades lower than 60); grades of retained students; number of evasions.

The statistical analysis consisted of the percentages of approved and retained students in relation to the number of enrolled students and its respective mean grades. The evasion percentage was also shown, referring to the infrequent students.

Results and discussion

Table 1 shows the statistical analysis regarding to the organic chemistry students before and during the pandemic.

Table 1. Statistical analysis of the organic chemistry students' performance during the 2018 and 2020 semesters.

Semester	N° of students	Approved (%)	Approved Mean Grades	Retained (%)	Retained Mean Grades	Evasion (%)
1°/2018	110	30	6,16	50,91	3,23	19,09
2°/2018	113	44,25	6,54	31,86	2,94	23,89
1°/2020	214	80,37	7,25	13,08	3,44	6,54
2°/2020	123	49,59	6,46	30,89	2,67	19,51

Analyzing Table 1's 2020 first semester, it can be seen a bigger number of enrolled students in detriment of the two 2018 semesters, and even the second 2020 semester. This phenomenon is also consequence of the COVID-19 pandemic; because, in early 2020, classes were suspended without a return date for the activities, however, there was enrolled students in Organic Chemistry. When activities resumed, in addition to the already enrolled students, there was also the arrive of new students at the university, which led to the bigger number of students in this semester. The percentage of approval was considerably high compared to other semesters in accordance to the approved mean grades. 2020's second semester was close to 2018's first semester. In 2020's first semester can be noticed that the evasion was significantly less than other semesters

Figure 1 shows the comparison between the percentages of approved and retained organic chemistry students and evasion during the 2018 and 2020 semesters.

It was observed that the approved means in 2020's first semester were different from the other semesters, this is justified by the number of enrolled students and the adaptation period of the teacher to the emergency remote teaching. In addition, in-person classes suspension and implementation of a new digital system brought with it limitation problems of the fluidity of teaching, such as: the absence of psychological support for teachers; low quality of teaching, which can be justified by an irregular planning of activities adapted to the new methodology; work overload; students dissatisfaction; irregular or inexistent student access to the technology needed for the new digital system. According to Gusso et al. (2020) a new reality is expected in higher education institutions in the coming years.

In 2020's second semester, also in remote format, the obtained results were closer to 2018's semesters. Those results could only be obtained because teachers adapted to remote teaching and were able to assess students performance more effectively. Therefore, it was observed some positive points of the new digital methodology through the development of skills implanted by professionals from all areas of education, such as: active learning and collaboration for the execution of tasks through access by everyone at all times. Teachers can test and combine new methods with the power of initiative and contribute to the evolution of education, promoting learning more integrated with the academic community, more autonomy and protagonism from the students.

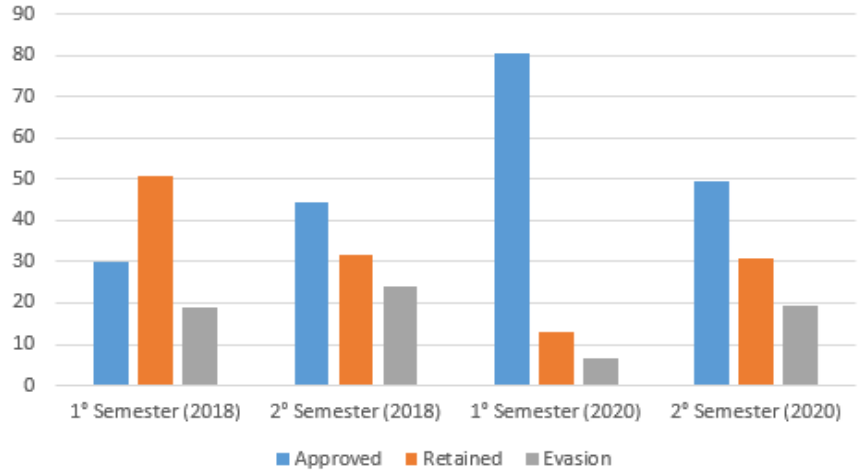

Figure 1. Comparison between the percentages of approved and retained organic chemistry students and evasion during the 2018 and 2020 semesters

Figure 1 makes a parallel between the first and second semester of 2018, year before the outbreak of the pandemic, when there was still the mentorship program. It was from 2007 that Brazil began deep changes in the academic scenery of the public universities, by expanding vacancies with quality education, inclusion of all localities and of students with the aim of new social and economic ideologies. Furthermore, in 2016, was created the REUNI (Restructuration and Expansion of Federal Universities) program, which aimed at increasing the number of vacancies, also creating nocturnal periods, contributing to less evasion rates and greater adherence of students to education, reviewed methodologies and diversification of courses with improvement in pedagogical processes that ranges from basic education to graduation and increase in assistance and inclusion programs. In addition to REUNI, new programs to promote higher education appeared, such as PROUNI, FIES and the strengthening and restructuring CEFETs and IFETs (Costa et al., 2017).

The increase of vacancies brought with it some problems, because, when integrating students from all social classes with different levels of learning, flaws in basic education were noted; especially in the disciplines of exact and natural sciences, which generates an increase of retention, evasion or creates a delay in completing courses. The Tutoring Program in Chemistry and Agricultural Sciences emerged as a countermeasure to this problem, working on the basic concepts of chemistry with the aim of promoting the discipline study that is present throughout the course.

In accordance with Costa et al. (2017), years were the Chemistry Tutoring Program was developed, there was an increase in approvals from 23% to 36% and substantial decrease in retention and evasion, which can be seen in 2018. Values referent to the start of the pandemic, 2020's first semester don't reflect the reality of students, the high rate of approval isn't linked to assimilation quality of the students. The cause is linked to the evaluation methods inherent to the moment in which educational institutions had to adapt to the new educational reality. The second semester of 2020 revealed greater uniformity with the results of 2018, when in-person classes were taken. This is justified by a better adaptation of both educational institutions and their teachers, as well as students.

Conclusion

Variations can be notice over the rate of approval, retention and evasion of the semesters, which are related to the applied methodologies. 2020's first semester was marked by the best results, both in approvals and grade means, in addition to the low retention and evasion rate. This phenomenon is justified by the adaptation period needed amidst the start of the COVID-19 pandemic that challenged the entire academic community.

The evaluation methodology was yet to be adapted since they aimed to validate the knowledge that was absorbed only in class; with the remote semesters, students were presented with more freedom and sources of consultation for studies, creating the need for new evaluation methodologies. In the subsequent remote semester, with the new adapted methodology, the achieved results were closer to 2018's, the year before the beginning of the pandemic.

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