


Analysis of failures in chemistry-related disciplines and the creation of a leveling discipline

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Maria Lucia Teixeira Guerra de Mendonça¹, Flávia de Almeida Vieira², Carla Bilheiro Santi³ and Rosana Petinatti da Cruz⁴

ABSTRACT

The objectives of this work are: to analyze the low performance in the disciplines of General Chemistry I and Environmental Chemistry, between the years 2012-2 and 2016-2, in the Higher Course of Environmental Management, at the Federal Institute of Rio de Janeiro (IFRJ) of the Maracanã Campus; report the creation of a leveling discipline called "Fundamentals of Chemistry", which aimed to mitigate the low performance in Chemistry-related disciplines, due to the high retention and, consequently, the dropout of students; We also investigate the performance of students after the introduction of this discipline in the course between 2017-1 and 2018-2. The methodology used was the elaboration of graphs that could show the percentage of failures of students in these two disciplines, over the years, before the creation of the leveling discipline, and after. The results were very worrying. The discipline of Environmental Chemistry had rates of more than 60% of failures, from 13% in the year 2016-1 alone. In the discipline of General Chemistry I, the situation was much worse, with the lowest index, in 2014-1 and 2015-1, equal to 59%. After the creation of the leveling course, the results improved significantly for the Environmental Chemistry course, but not for the General Chemistry I course, which still had high failure rates. It is concluded that it is still necessary to investigate more about the conjuncture of failure, retention, probable cause of abandonment of the course, that is, of dropout.

Keywords: Chemistry, Repetition, Retention, Evasion.

¹ Dr. in Sciences-Analytical Chemistry. Federal Institute of Rio de Janeiro (IFRJ).
E-mail: maria.mendonca@ifrj.edu.br

² Dr. in Sciences-Analytical Chemistry. Federal Institute of Rio de Janeiro (IFRJ).
E-mail: flavia.vieira@ifrj.edu.br

³ Master in Geography. Federal Institute of Rio de Janeiro (IFRJ).
E-mail: carla.santi@ifrj.edu.br

⁴ Dr. in Sciences-Analytical Chemistry. Federal Institute of Rio de Janeiro (IFRJ).
E-mail: rosanapetinatti@gmail.com



INTRODUCTION

The Law of Guidelines and Bases (LDB 9394/96) provided the authorization and recognition of educational institutions, which caused an expansion of higher education in Brazil, consequently generating a greater influx of students from different social classes (OLIVEIRA *et al*, 2019).

Corroborating this fact, the census of higher education, carried out by the National Institute of Educational Studies and Research Anísio Teixeira (INEP, 2016), reports that, simultaneously with the increase in the number of students entering higher education, the dropout of students has intensified.

This reality leads to negative results in the academic, social and economic spheres. The student starts to spend more time to finish his graduation, postponing the completion of the course, which delays his insertion in the labor market and, therefore, a greater financial expense on the part of the institution, which stays with this student for a longer time than expected (PEREIRA *et al*, 2015).

The retention of the student, due to being failed a few or several times, in certain disciplines considered difficult to understand, especially those of the basic cycle, the initial period of the course, with emphasis on the discipline of General Chemistry (YAMAGUCHI; SILVA, 2019), favors evasion (SARAIVA; DANTAS; RODRIGUES, 2019).

Based on this situation, which attests to the high retention and consequent dropout of students, this paper reports the creation of a leveling discipline called "Fundamentals of Chemistry", in the Higher Course of Environmental Management, at the Federal Institute of Rio de Janeiro (IFRJ) of the Maracanã Campus, in an attempt to mitigate the low performance in the disciplines related to Chemistry (General Chemistry I and Environmental Chemistry).

RETENTION/EVEVASION

In the literature, there are several studies on the subject, such as that of Garcia and Gomes (2022), who carried out a study on the causes of evasion in academic production, verifying a very large number of studies on this theme. The main causes found by the cited authors, in order of relevance, were:

1. Difficulty and academic performance/failure;
2. Lack of time to reconcile work and study;
3. Lack of knowledge in high school;
4. Didactics and methodology of teachers and the institution;
5. Dissatisfaction with the course/did not like it;
6. Financial situation;
7. Vocational;
8. Admission to the course due to lack of option/second option;



9. Lack of time to dedicate to studies;
10. Infrastructure;
11. Low valuation of the profession/teacher (Bachelor's degree);
12. Personal problems;
13. Availability of vacancies/labor market;
14. Institution/quality of the course and
15. Miscellaneous (GARCIA; GOMES, 2022, p.947,948).

The work of Garcia and Gomes (2022) points out that the first three items (difficulty and academic performance/failure, lack of time to reconcile work and study, and lack of knowledge in high school) are presented as a cause of dropout in a large number of studies, revealing the need, on the part of the institution and teachers, to present alternatives for their elimination or, at least, for its minimization.

This is because, to the extent that the student enters the university and starts to belong to a certain institution, the previous failures in the student's education also belong to the institution and the teacher, who have to take responsibility and do their best not to lose this student, who may drop out of the course.

Dropout and/or retention, in addition to causing enormous frustration to the student, which is one of the main factors pointed out by Oliveira *et al* in their work (2019), there is the economic factor, which causes a waste of resources in both the private and public sectors. In the latter, the situation is even worse, due to the scarce resources allocated to education, as mentioned in the work of Silva *et al* (2007):

"Student dropout in higher education is an international problem that affects the outcome of education systems. The losses of students who start but do not finish their courses are social, academic and economic waste. In the public sector, these are public resources invested without due return" (SILVA *et al.*, 2007, p. 642).

The Law of Guidelines and Bases (LDB 9394/96) points out three types of retention: failure due to grade, lack and locking. In the work of Yamaguchi and Silva (2019), retention is associated with low performance and, especially, in the discipline of General Chemistry, which belongs to the initial period of several courses. Compared to failure by attendance, the situation is worrisome, because this discipline is a prerequisite for others in several undergraduate courses.

These authors also concluded in their work:

"Based on the results obtained, it is suggested that retention results fundamentally in the following variables: little affinity with the discipline, socioeconomic difficulty, inadequate study methodology, and deficiency in basic education, especially related to the disciplines of science and mathematics" (YAMAGUCHI; SILVA, p.353, 2019).



The deficiency in basic education can be seen in studies related to high school itself, in which students already present the discipline of Chemistry as difficult to understand.

In the work of Mendonça and Cruz (2008), the authors investigated the difficulties in learning the discipline of Chemistry, from the student's point of view, and found that the majority of the students investigated, 73%, (population of 121 students in total of the first, second and third grades of the various shifts in the morning, afternoon and night) thought that the discipline of Chemistry was difficult or very difficult to understand. This was ratified by the low performance of the students in the assessments. This situation experienced by high school students is reflected in higher education, with gaps in learning and/or lack of understanding.

Rosa and Santos (2018) pointed out basic deficiencies as one of the causes of dropout in undergraduate courses at the Federal University of Goiás (UFG):

[...] "You have to understand what led them to give up on it. Therefore, the number of failures was investigated, with a view to discovering the influence of low academic performance on the option to abandon the course" (ROSA; SANTOS, 2018, p.486).

The authors address the need to provide pedagogical assistance to students who have learning gaps, which have not been remedied in basic education, which is the cause of repetition in certain subjects, especially those in the initial periods, causing them to drop out of the course (ROSA; SANTOS, 2018).

ALTERNATIVES TO SOLVE OR MITIGATE RETENTION/EVASION

As previously mentioned, there are several studies in the literature to investigate retention and evasion, based on the verification of their causes, which point to the need to develop suggestions capable of eliminating or, at least, minimizing the effects of this conjuncture.

The following items can be grouped: lack of time to reconcile work and study, financial situation, and lack of time to dedicate to studies (GARCIA; GOMES, 2022) as a topic related to the student's economic situation; Therefore, it is possible to think about the institution providing scholarships with realistic values, which allow the student to dedicate himself to academic studies and his training without dividing his time with work.

Regarding the item on infrastructure (GARCIA; GOMES, 2022), is related to the institution's environment, which must have comfortable libraries with up-to-date collections, adequate places for meals, and areas reserved for group or individual studies, which does not occur in many institutions, which do not even have convenient classrooms.

Monteiro and Ianuskieztz (2018) address, in their work, the extreme relevance of the environmental factor for the student's sense of belonging to the institution: "The importance of identity construction within the university context for student-school community interaction. The

non-construction of identity in this context can lead to evasion" (MONTEIRO, IANUSKIEKTZ, p. 265, 2018).

It is important to compile topics related to the student's personal identity, such as dissatisfaction with the course/did not like it, the vocational issue and admission to the course due to lack of option/second option (GARCIA; GOMES, 2022). Hence the importance of applying vocational tests in High School, in order to better guide your choices, causing fewer failures:

[...] "as the major factors identified as a cause of dropout precede the student's entry into the University, alternatives were identified to minimize dropout, the application of vocational tests and the insertion of discipline or content on professions in high school, both in public and private education, in order to support the student's choice and decision about his or her professional future" GARCIA; SANTIAGO, p. 49, 2015).

It is noted that the vocational test could be applied thus avoiding evasion and, consequently, economic waste on the part of the government and frustration on the part of the student.

With regard to the topic of didactics and methodology of teachers and the institution (GARCIA; GOMES, 2022), it is necessary to assume that, from the moment the student enters the undergraduate program, he becomes the responsibility of this institution, having the obligation to welcome him as he is. In his work, Silva (2014, apud ROSA; SANTOS, 2018) states: "The educational entity should didactically prepare its faculty to teach the student who receives and not the student who would like to receive" (emphasis added), which shows how important it is for the institution to have knowledge of the student's previous education and create strategies to retain the same in the course chosen by him, so that your training reaches the maximum possible excellence.

The items difficulty and academic performance/failure and lack of knowledge in high school (GARCIA; GOMES, 2022), referring to students' disabilities brought from High School, constitute, in our view, the most relevant for the dropout of students in Higher Education courses. This concern is evident in Veloso *et al* (2018): [...] "of the high rate of school dropout, the Higher Education Institutions, and, in our case, the Faculty created school leveling instruments to try to retain their students" [...] (VELOSO *et al*, p.2, (2018). Among these instruments, leveling disciplines were created with topics of mathematics, general and experimental physics.

The work of Yamaguchi and Silva (2019) analyzes retention in the discipline of General Chemistry, at the Federal University of Amazonas, and the creation of a leveling discipline is proposed to mitigate retention and, consequently, dropout. This fact demonstrates how the difficulty in the disciplines related to chemistry is worrisome and constitutes a large portion of the cause of dropout from some courses.



DEGREE IN ENVIRONMENTAL MANAGEMENT TECHNOLOGIST

The Brazilian Institute of Geography and Statistics (IBGE) (2003) shows that the number of students enrolled in high school is much higher than the number of young people enrolled in higher education, thus pointing to a large number of young people without access to undergraduate education.

In 2007, the Federal Government instituted the Support Program for the Restructuring and Expansion Plan of Federal Universities (Reuni), with the objective of creating conditions for the expansion of access to higher education. Investment in the creation of new universities and/or new campuses has consequently increased the number of vacancies.

In 2009, at the Federal Institute of Rio de Janeiro (IFRJ), Rio de Janeiro campus, there was an expansion of higher education courses and the Environmental Management Technologist (STGA) course was created. The curriculum of this course presents scientific and management bases of higher education, aiming to meet the labor market (PROJETO POLÍTICO PEDAGÓGICO-PPP, 2018).

All this investment, however, did not mitigate the problem discussed. Mazola and Allevato (2016) carried out a study with the objective of verifying, in research published in books, journal articles and annals of events, the approach to the learning difficulties of students entering Higher Education, in relation to the contents of mathematics discussed. They were able to observe a large number of authors concerned with this theme, in the most diverse degrees, indicating that the problem is present not only in the IFRJ, in the CSTGA, but in the entire Brazilian territory.

Regarding the discipline of chemistry, which studies "the composition, structure, properties of matter, the changes undergone by it during chemical reactions, and its relationship with energy" (FNDE, 2023), its definition shows how broad it is and with many contents correlated to mathematical concepts, causing an even greater difficulty in understanding it. The fundamental thing, however, is to try to develop in the student the competence to act critically in the decisions of the community (SANTOS and SCHETZLER, 1996, p. 29).

Em Veras et al. (2010):

"It is known that students have great difficulty in assimilating the chemistry contents covered in the classroom, that is, the classes are mostly only theoretical. This leads to misunderstanding and even a lack of interest in the discipline. It is believed that the teaching of chemistry should contribute to a more comprehensive view of knowledge, emphasizing in the classroom knowledge that is relevant and can interact in the student's daily life. Students understanding this from an early age find that studying chemistry can be easy and fun, especially when this teaching is done in a practical and attractive way. Chemistry is an eminently experimental science; Hence the importance of practical classes. Classes in the laboratory provide a greater approximation of students with the discipline" (VERAS et al, 2010).



Therefore, it is possible to verify the importance for the student of practical classes, which enrich the chemical contents and make comprehension easier. However, although the disciplines of General Chemistry I, II and Environmental of the CSTGA present a reasonable number of practical classes, which try to alleviate the serious situation of these disciplines, it is found that it is necessary to do something more, which makes the understanding more effective, hence the importance of creating a basic discipline, teaching elementary and primordial contents for the understanding of the knowledge of these disciplines.

CONSTRUCTION OF THE FUNDAMENTALS OF CHEMISTRY DISCIPLINE

Regarding the approval of the Environmental Chemistry I course, the situation of the students proved to be serious. The highest failure rates occurred in the semesters of 2012-2, 65%, and 2014-1, 62%, and the lowest was in 2016-1, 13% (Figure 1), thus showing that, on average, the number of failures is high.

Failures in the discipline of General Chemistry I are even higher, with the lowest rate in 2014-1 and 2015-1 equal to 59% and, in all other semesters, the rate was even higher than this value, reaching up to 90% failure in 2015-2 and 2016-1 (Figure 1).

Analyzing the data, it is observed that the situation was alarming in relation to these disciplines, in which the performance was minimal, with the aggravating factor of being disciplines of initial periods of the course, thus causing retention and, probably, dropout. In view of this fact, and after many frustrations from both teachers and students, some action should be taken.

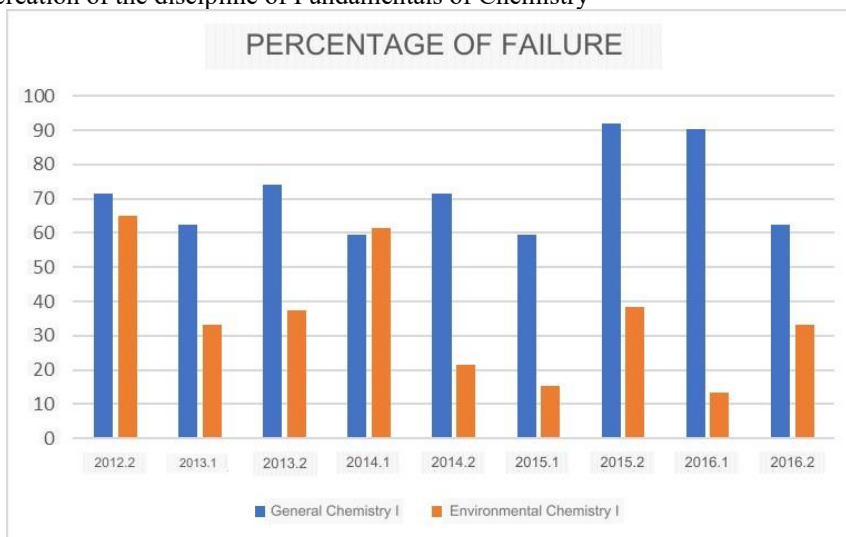
The teacher of Environmental Chemistry I (QGI) observed a great difficulty on the part of the students to understand the basic concepts of chemistry, necessary for their discipline, which caused an obstacle in the understanding of Environmental Chemistry I (IAQ). Observing the number of failures in General Chemistry I (Figure 1), he proved that this cognition was also greatly compromised. The two disciplines belong to the first semester (QGI) and the second semester (QAI) of the STGA course.

Through many discussions among the professors of the course, in the sense of what could be done to mitigate the painful situation for both teachers and students, with regard to the probable causes of the student's failure, retention, frustration, and, consequently, his/her dropout, the collegiate of the STGA course in 2016-2, proposed the formation of the discipline Fundamentals of Chemistry for the year 2016-1, as an elective course, in order to assist in the knowledge and mastery of the basic contents of Chemistry.

The course has been offered since 2016.2. Since then, on the first day of class, a diagnostic assessment is applied to verify that all enrolled students have an indication to attend it and to indicate which contents of the syllabus should be deepened. In odd-numbered periods, the entry of freshmen

in the CST in Environmental Management is in the afternoon shift, while in the even-numbered periods, in the night shift. In the beginning, this discipline was not offered in the shift in which the incoming students were enrolled, which did not promote their adherence.

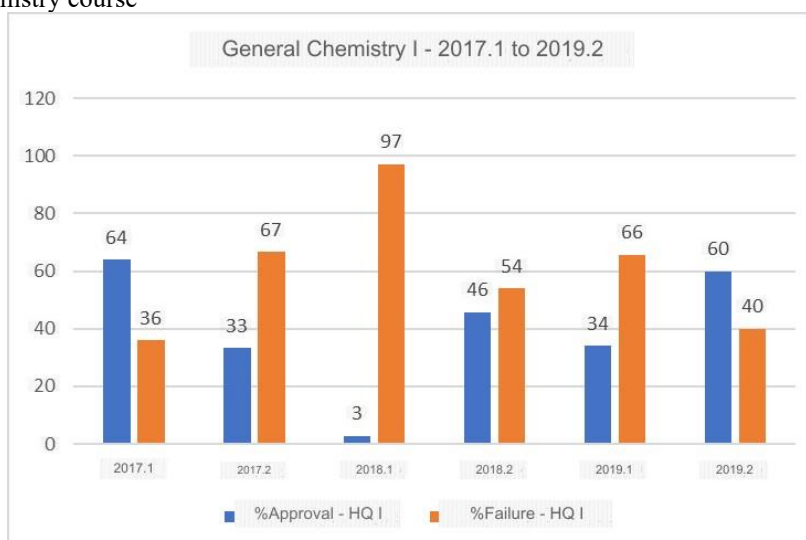
Figure 1 - Percentage of students who failed the disciplines of General Chemistry I and Environmental Chemistry I in the periods prior to the creation of the discipline of Fundamentals of Chemistry



Source: Authors (2023)

With the commitment of the Institute's management, as of 2017.2, a schedule was reached in the schedule for incoming students, who were automatically enrolled during the period of their admission.

Figure 2 - Comparison chart of students who passed and failed the General Chemistry I course after the creation of the Fundamentals of Chemistry course



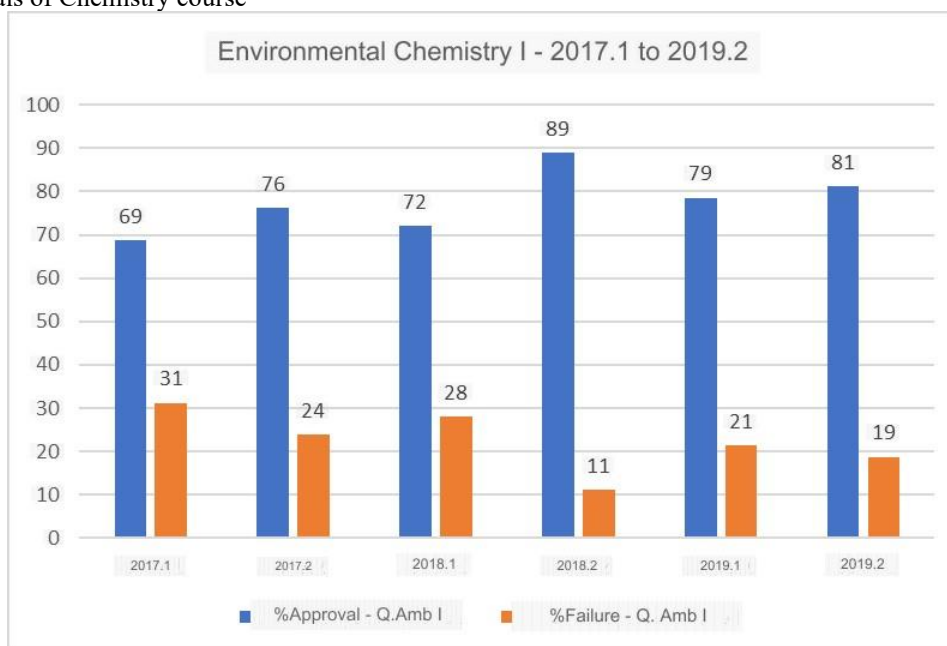
Source: Authors (2023)

Analyzing the number of students who passed and failed in the General Chemistry I course (Figure 2), after the creation of the Fundamentals of Chemistry course, it is concluded that, in 2017-1

and 2019-2, the results were very good, but in the other semesters this did not occur. This finding makes us carefully examine this conjuncture and verify that the discipline of General Chemistry I presents a turnover of teachers who teach it, showing, as previously mentioned, that the didactics and methodology of the teachers influence the student's performance (ASSIS; MELO, 2015).

Examining the percentage of students who passed and failed in the discipline of Environmental Chemistry (Figure 3), after the creation of the discipline of Fundamentals of Chemistry, very good results are observed in all semesters, with the number of approved students being much higher than the number of failures. This result was presumably due to the fact that she was the same professor who taught both disciplines (Fundamentals of Chemistry and Environmental Chemistry). The professor, who taught the basic contents pertinent to Environmental Chemistry, tried numerous times to dialogue with the discipline of General Chemistry I, and the occurrence of this partnership showed reasonable results, such as that of 2019-2, with 60% approved and 40% failed (Figure 2).

Figure 3 - Comparison chart of students who passed and failed the Environmental Chemistry course after the creation of the Fundamentals of Chemistry course



Source: Authors (2023)

FINAL THOUGHTS

The situation investigated was and still remains very worrying, requiring a more detailed analysis of the circumstances. It is perceived that there should be a greater integration between the teachers of the various disciplines, that in the collegiate there would need to be more pedagogical discussions and, also, a follow-up of the syllabus, in the contents in which the students presented more difficulty, so that the leveling discipline (Fundamentals of Chemistry) would address certain



topics in more detail, or that there would be a modification of the syllabi itself. in order to adjust to the needs of the students and the course.

Currently, the possibility of online meetings greatly facilitates the aggregation between teachers and the course coordination, with the opportunity for everyone to stand up and have the floor to address what they think and feel about a given situation.

The role of the teacher is much greater than simply going to the institution to teach. It is necessary for him to commit himself to the student, in an integral way, in order to actually be called a teacher.



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