

Strategic guide to combating dropout and promoting persistence in undergraduate programs in exact sciences education

ABSTRACT

The aim of this study is to elucidate the process of developing and constructing a strategic guide aimed at combating dropout and promoting persistence in Exact Sciences Undergraduate courses, with a special focus on the one offered by the University Federal do Rio Grande at the Santo Antônio da Patrulha campus. To compile this document, we draw upon three primary sources: 1) a review of national literature regarding the causes of dropout and persistence, as well as widely disseminated strategies to address dropout and promote persistence; 2) the contributions of Vincent Tinto, particularly concerning a) guidelines for institutional actions, b) the Model of Student Motivation and Persistence, and c) academic, social, and curricular support guidance; and 3) an empirical study conducted with the Exact Sciences Degree at the University Federal do Rio Grande. Consequently, the resulting strategic guide (an educational product) includes: i) a brief report on the average profile of dropout, enrolled, and graduated students from the program; ii) identification of the causes of dropout and persistence among these students; and iii) proposal of strategies to combat dropout and promote persistence, linking them with the identified causes and with the constructs described by Vincent Tinto as determinants of dropout.

KEYWORDS: Dropout; Persistence; Exact Sciences Undergraduate; Educational Product.

Guia estratégico para combate à evasão e fomento à persistência em licenciaturas de ciências exatas

RESUMO

O objetivo deste estudo é elucidar o processo de desenvolvimento e construção de um guia estratégico voltado para combater a evasão e promover a persistência em cursos de licenciatura em Ciências Exatas, com foco especial na oferecida pela Universidade Federal do Rio Grande no campus de Santo Antônio da Patrulha. Para a elaboração deste documento, nos baseamos em três fontes principais: 1) uma revisão da literatura nacional acerca das causas da evasão e da persistência, bem como das estratégias amplamente difundidas para enfrentar a evasão e promover a persistência; 2) as contribuições de Vincent Tinto, especialmente no que diz respeito a) às diretrizes para ações institucionais, b) ao Modelo de Motivação para a Persistência do Estudante e c) às orientações de apoio acadêmico, social e curricular; e 3) uma pesquisa empírica realizada com o curso de Licenciatura em Ciências Exatas da Universidade Federal do Rio Grande. Com isso, o guia estratégico resultante (um produto educacional) inclui: i) um breve relatório sobre o perfil médio dos alunos evadidos, matriculados e egressos do curso; ii) a identificação das causas da evasão e da persistência desses alunos; iii) e a proposição de estratégias para combater a evasão e promover a persistência, relacionando-as com as causas identificadas e com os construtos descritos por Vincent Tinto como determinantes da evasão.

PALAVRAS-CHAVE: Evasão; Persistência; Licenciatura em Ciências Exatas; Produto Educacional.

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INTRODUCTION

Entering university is often portrayed as a milestone of personal and professional achievement, representing a window of opportunity for knowledge, intellectual growth, and professional development. However, behind this scenario of hope and expectation lies a reality that many face dropout. This complex and multifaceted phenomenon casts a shadow over the university dream, frustrating aspirations and challenging educational systems worldwide (Gaiosio, 2005).

In this context, we draw attention to the programs that frequently record the highest dropout rates, such as teaching degrees in the Exact Sciences (Palharini, 2004). In Brazil, only 16.7% of students entering higher education programs in 2022 chose a teaching degree (*Licenciatura*) (Brasil, 2023), which further contributes to the low number of qualified teachers in recent years.

Furthermore, few studies have focused on analyzing student persistence (e.g., Maciel, Cunha & Lima, 2019; Pigosso, Ribeiro & Heidemann, 2020), and there are few works that point to institutional strategies for combating dropout and promoting persistence (e.g., Carniel & Espinosa, 2024a; Coimbra, Silva & Costa, 2021; Heidemann, Moraes & Giongo, 2020; Moraes, Heidemann & Espinosa, 2020). In line with this, Oliveira and Silva (2020), through a literature review, demonstrated the existence of a gap regarding studies that investigate how, and to what extent, the implementation of certain actions—such as Research, Teaching, and Extension Projects and curricular reforms of a given program—impacts the dropout or retention of teaching-degree students.

With the aim of contributing to the reduction of university dropout, particularly in teaching-degree programs in the field of Exact Sciences, we developed a strategic guide (an educational product/process) written in accessible language and geared toward actions for different institutional stakeholders. This guide is necessary because the agents interested in mobilizing actions to combat dropout usually need to turn to scientific articles, which, in most cases, do not focus on presenting strategies to combat university dropout, especially in the Brazilian context.

Accordingly, in this article we address the different aspects related to the conception, theoretical foundation, and structuring of an educational product that played a crucial role as an integral part of a thesis from the Professional Master's Program in Teaching of Exact Sciences at the Federal University of Rio Grande (FURG). Thus, the educational product (Silva, 2022b) consists of a strategic guide aimed at combating dropout and fostering persistence in teaching-degree programs in the Exact Sciences, for the Teaching Degree in Exact Sciences (*Licenciatura em Ciências Exatas*—LCE) at FURG, Santo Antônio da Patrulha (SAP) campus.

To prepare this document, we drew on three main sources: 1) a review of the national literature on the causes of dropout and persistence, as well as on the widely disseminated strategies for addressing dropout and promoting persistence (Carniel & Espinosa, 2024a); 2) the contributions of Vincent Tinto, especially with regard to a) guidelines for institutional action (Tinto, 2012), b) the Model of Student Motivation for Persistence (Tinto, 2017), and c) guidance on academic, social, and curricular support (Tinto, 2022); and 3) empirical research conducted

with the LCE at FURG (Silva, 2022a; Carniel & Espinosa, 2024b). As a result, the resulting strategic guide (an educational product) includes: i) a brief report on the average profile of students who dropped out of, were enrolled in, and graduated from the program; ii) the identification of the causes of dropout and persistence of these students; and iii) the proposal of strategies to combat dropout and promote persistence, relating them to the identified causes and to the constructs described by Vincent Tinto as determinants of dropout.

In what follows, we present some strategies for combating dropout and fostering persistence in the form of an educational product found in the literature, our theoretical framework concerning Vincent Tinto, the methodological path, our results—including a presentation of the educational product—and, finally, the concluding remarks.

STRATEGIES FOR COMBATING DROPOUT AND FOSTERING PERSISTENCE AS AN EDUCATIONAL PRODUCT

An educational product can take various forms, such as a didactic sequence, an application, a piece of equipment, a virtual environment, a text, among others. According to Moreira and Nardi (2009), the development of an educational product is intrinsically linked to professional master's programs in the Sciences, often being an integral part of the thesis required by these programs.

The educational product presented in this context—specifically a strategic guide for addressing dropout and promoting persistence in Exact Sciences programs—has indirect implications for Basic Education, since it focuses on initial teacher training. In this sense, the educational product can contribute significantly to improving the quality of teaching and learning processes.

In international contexts, there are some materials that are close to what we developed as an educational product. More specifically, most of these materials are of the report type, which also present strategies that are already applied in Higher Education Institutions (HEIs) (Hanover Research, 2014; Tinto & Pusser, 2006; Engle & Tinto, 2008), as well as in the form of practical guides (Institute of Education Sciences, 2008).

In the national context, we conducted searches on the eduCAPES platform using the descriptors “educational product” and “dropout”, “educational product” and “retention”, “educational product” and “persistence”, and “educational product dropout”. Applying exclusion criteria, such as works without an associated file and duplicates, we obtained 32 results (August 8, 2022). The educational products found were almost entirely (n=29) from the Graduate Program in Professional and Technological Education (ProfEPT), which is offered nationwide. Thus, these works are geared toward Professional and Technological Education at the basic level, which differs in many respects from Higher Education.

The educational product *Manual de apresentação do curso de formação de docentes em nível médio* [Presentation Manual for the Secondary-Level Teacher Training Program] (Albano & Passos, 2022), produced in the Graduate Program in Teaching at the State University of Norte do Paraná, is geared toward secondary education; and only the products *Software de Gestão de Evasão* [Dropout Management Software] (Ferrari & Schimiguel, 2020), produced in the Graduate

Program in Science and Mathematics Teaching at Cruzeiro do Sul University, and *Instrumento de registro dos motivos da desistência do curso de graduação e estratégias de redução* [Instrument for Recording the Reasons for Undergraduate Program Withdrawal and Reduction Strategies] (Cunha & Rossit, 2021), from the Graduate Program in Health Sciences Teaching at the Federal University of São Paulo, are geared toward Higher Education.

Furthermore, through Google Scholar we also found the thesis by Casimiro (2020), likewise geared toward Higher Education; however, the graduate program to which it was affiliated does not require the final construction of the educational product, only its proposal. We can therefore conclude that the only educational products geared toward Higher Education found in our searches are those by Ferrari and Schimiguel (2020) and Cunha and Rossit (2021). Nevertheless, both differ from our proposal: the former is a questionnaire administered directly by the Undergraduate Office of the Baixada Santista Campus of the Federal University of São Paulo at the moment of formalizing withdrawal, with the aim of investigating the motivations behind dropout; the latter is a piece of software, also aimed at reducing dropout, but with a distinct approach.

Based on this identification of the absence of an educational product such as ours, the first author's thesis aimed to develop a disseminable strategic guide for combating dropout and fostering persistence, intended for the agents involved in teaching-degree programs in the Exact Sciences (Physics, Chemistry, and/or Mathematics)—more specifically, the LCE at FURG—such as the program coordination, the Structuring Teaching Group (*Núcleo Docente Estruturante*—NDE), professors, students, and other interested parties.

THEORETICAL FRAMEWORK: VINCENT TINTO

In 1975, Vincent Tinto, a leading authority in dropout studies, introduced the *Student Integration Model*, which establishes two main dimensions that can favor student retention: academic integration and social integration. *Academic integration* usually occurs in the formal settings of the university, for example, in the interactions that take place in the classroom. In addition, a student's participation in academic events, teaching projects, research, and extension activities is also considered academic integration. *Social integration* involves informal relationships that the student establishes with peers, which may occur in daily life, during breaks between classes, and at social events inside and outside the university, such as parties, cultural events, and so on.

From a more practical perspective, in 2012 Vincent Tinto presented four conditions for student success: expectations; support; assessment/feedback; and involvement. The first refers to the *expectations* that students hold regarding their needs, future aspirations, goals, beliefs, and values in relation to academic progression.

Student support can be of three types: academic, social, and financial (Tinto, 2012). *Academic support* is related to measures such as guidance, counseling, scholarships in institutional programs, as well as participation in seminars, foundational courses, tutoring, and mentoring. *Social support* refers to actions that

foster interaction with peers, professors, and staff, both inside and outside the classroom. *Financial support* also plays an important role in student retention.

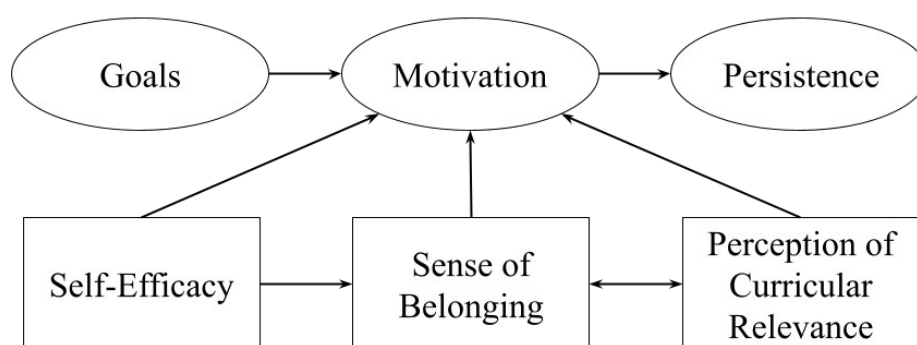
The *assessment and feedback* dimension represents the importance assigned to teaching and learning environments (Tinto, 2012). In environments rich in assessment and feedback, students and professors are more likely to adjust their behaviors in pursuit of satisfactory results. This process provides important information about students' difficulties and the effectiveness of teaching practices, while also indicating which actions can be developed and providing early-warning information about a student's condition, thereby enabling early interventions to prevent dropout (Tinto, 2012; Vázquez-Alonso & Manassero-Mas, 2016).

According to Tinto (2012), the fourth condition for success is student *involvement*. Students engaged in interactions with peers, professors, and staff, both inside and outside the classroom, tend toward persistence. Social and academic involvement are different facets of the same dimension that may overlap and directly influence one another.

In 2017, Tinto introduced the *Model of Student Motivation for Persistence*, in which—despite various approaches to retention through the lens of institutional action—it is necessary to recognize that the student intends to persist. According to Tinto (2017), the article sought to continue a necessary discussion about the ways in which institutional action can promote student motivation to persist and, in turn, increase student persistence through to the completion of the higher education program. Tinto's (2017) model can be summarized by the diagram in Figure 1, which presents the most important constructs for student motivation and persistence.

Figure 1

Model of Student Motivation for Persistence



Source: Tinto (2017, p. 3).

According to Tinto (2017, 2022), a student's persistence in each undergraduate program is intrinsically related to their motivation to complete it. However, motivation can be unstable and variable, and it is affected by the student's perceptions regarding their own abilities (self-efficacy), their social and academic sense of belonging, and the relevance attributed to the program's curriculum. It thus becomes clear that the student must have the goal of completing the program; this, however, is not a sufficient condition for its completion. There are students who enter their desired undergraduate program

but intend to change institutions to complete it, and others who “may not intend to transfer but do not place great importance on completing their degree in the institution in which they first enroll” (Tinto, 2017, p. 2).

Moreover, the goal may differ among students: some may be more concerned with their learning, autonomy, and professional career; others with the student aid provided by the university. In some cases, there is no goal at all. When the goal is unclear or weakly established, any negative experience at the university may be enough to lead the student to drop out. Considering this, Tinto turns his attention to students who, upon entering an undergraduate program, hold some goal and/or commitment regarding its completion. For Tinto (2017, 2022), it is necessary for higher education institutions to understand their students’ perceptions of the elements that most strongly impact their decisions to persist or drop out, because only when they understand these perceptions will they be able to act “to impact those decisions in ways that enhance the likelihood of greater persistence while also addressing the continuing gap in college completion between students of different attributes and backgrounds” (Tinto, 2017, p. 11).

In what follows, we individually describe the three predictor constructs proposed by Tinto (2017) and the academic, social, and curricular support guidelines that can be promoted by HEIs (Tinto, 2022).

SELF-EFFICACY

Self-efficacy is defined as the judgment one holds about one’s own ability to complete a certain activity or task (Bandura, 1986). In the context of university dropout, self-efficacy refers to the beliefs that the individual holds about their own ability to cope with the academic and social demands required by the university environment, such as performing well on examinations and advancing through the semesters of the program (Tinto, 2017, 2022; Moraes, 2020).

A low self-efficacy belief can hinder the conclusion of activities, even when the student can carry them out, leading them to feel demotivated. Conversely, high self-efficacy does not guarantee success in a task if the student lacks the necessary knowledge (Bandura, 1986).

It is essential that educational institutions monitor their students’ self-efficacy, especially during the first year of the undergraduate program period of adaptation that can be challenging, as it may be preceded by failures relative to secondary school (Tinto, 2017, 2022).

Bandura (1986) emphasizes that self-perception of efficacy (self-efficacy) is not static and directly influences individuals’ motivation and action. In practice, it is crucial that students maintain a high level of self-efficacy in relation to academic activities to avoid withdrawing from the program, even in the face of adverse experiences such as failing grades and low marks.

SENSE OF BELONGING

The sense of belonging is related to how integrated and included someone feels within a group, that is, the extent to which students see themselves as

members of a community of professors, staff, and other students and feel that their participation is valued and important to the group (Tinto, 2017, 2022). A low sense of belonging, or a feeling of exclusion or displacement, can lead to withdrawal from the program.

Beyond the social interactions that the student engages in individually, Tinto (2017) notes that the actions of the program coordination and the faculty are fundamental to creating an environment that promotes students' sense of belonging, since they reflect the institution's commitment to serving the interests of all students and help establish the climate within the classroom. That said, we understand that every interaction matters, because even a single negative interaction can reverberate into changes in students' sense of belonging within the institution.

Drawing on the Student Integration Model of 1975, it is possible to see that interactions that generate a sense of belonging occur both academically and socially. Social interactions usually take place through informal conversations with peers, professors, and other university staff, as well as at parties and cultural and sporting events. Academic interactions, in turn, normally occur during classes, in research, teaching, and extension groups, at scientific events, and so on.

PERCEPTIONS OF CURRICULAR RELEVANCE

For a program to be chosen well, it is important that the student identify with it. It is also necessary for the student to perceive its curriculum as essential and as preparation for their future profession. Difficulty in relating the content addressed in the courses to professional practice can influence the choice of whether to remain in the program. A curriculum that is regarded as unrewarding, irrelevant, or of low quality can contribute to student dropouts.

These issues are related to the construct of the perception of curricular relevance. A favorable perception of the quality and relevance of an undergraduate program's curriculum is also related to the teaching methods used by faculty, the student's perception of the quality of the HEI, and their own preferences and learning style (Tinto, 2017, 2022).

According to Moraes et al. (2020), the use of active methods in university teaching can contribute to students' self-efficacy beliefs and sense of belonging, as they feel more valued and confident as part of the HEI. The authors further state that the adoption of active methods in Science Teaching leads students to attend classes more regularly and, consequently, increases the retention rate and improves performance in courses and conceptual tests. Following our literature review, we can infer that active teaching methodologies can improve the perception of curricular relevance.

Regarding the Model of Student Motivation for Persistence, Tinto (2017) emphasizes that the proposed conceptual model is not comprehensive in terms of motivation but focuses specifically on the experiences within the institution that shape students' motivation, within the institution's sphere of influence. It considers both practice and theory, without considering experiences external to the university, which can also affect motivation. For example, even the most motivated students may be forced to leave college owing to external events. On

the other hand, some students may persist even when there is little sense of belonging or perception of curricular relevance, especially when the external benefits of obtaining a university degree are significant enough to motivate them to complete the program.

ACTIONS FOR ACADEMIC, SOCIAL, AND CURRICULAR SUPPORT

In view of students' academic performance problems, Tinto presents proposals related to *academic support*. For him, the university must make students aware that tutoring services and extracurricular courses are resources that can assist them, and that seeking such help should not be interpreted as a sign of failure (Tinto, 2022). Moreover, Tinto (2022) states that academic support in the first year should be early, before students' difficulties undermine their motivation to persist. To this end, he suggests that HEIs need to find ways of knowing not only which students need support but knowing this far enough in advance to make a difference in their performance.

Beyond tutoring services and courses that depend on students seeking them out, Tinto (2022) suggests that support should be more focused on the student's program, so that the nature of the support is tailored to the specific demands of that program. As an example, he points to the use of supplemental instruction, in which sessions are led by the support team or by students who excelled in the program in the previous year. Participation increases relative to the traditional methods discussed, because such sessions take place just before or after classes, facilitating access for students, even in online programs.

About classes, according to Tinto (2022), the evidence indicates that support is most effective at improving program performance when the program employs learning strategies that require students to apply their skills to solve problems specific to that program. In this sense, the professor may assign students a task that engages them in preparing materials to assist other students who have learning difficulties, such as producing tutorial videos.

We should note that, although the provision of academic support can have a direct impact on students' capacity to persist, it can also indirectly affect persistence through its impact on the student's academic self-efficacy. To the extent that providing academic support improves academic performance, this may also affect students' perceptions of their ability to cope with the academic demands of the program, which, in turn, increases motivation to persist.

Tinto (2022) also presents possible actions for *social support*. Peer mentoring is already a service offered by universities, consisting of advice provided by senior students to first-year students. In Brazil, this activity is commonly referred to as the Academic Mentorship Program (*Programa de Apadrinhamento Acadêmico or Mentoria Acadêmica*). For Tinto (2022), this action is important because the participating senior students can serve as role models whose experiences provide meaningful examples that the success of "students like me" is possible (vicarious experience). In other words, Tinto (2022) asserts that this sharing of experiences, from senior students to first-year students, can reshape new students' perception of the possibility of their own success at the university, with the

thought of “if they can do it, so can I.”; furthermore “they can provide advice to students that is often difficult for university staff to provide” (2022, p. 63).

Another action presented by Tinto (2022)—this one concerning *curricular support*—is the creation of learning communities for first-year students, where they can share experiences in a way that extends their classroom involvement beyond it, crossing academic and social boundaries through a network of supportive belonging that helps students manage the challenges that arise, especially during the first year. However, we must consider students who carry out other activities concurrently with the undergraduate program, so that their sense of belonging is also fostered. It is important that the promotion of a sense of belonging take place primarily within the classroom and laboratories, through actions involving the professor.

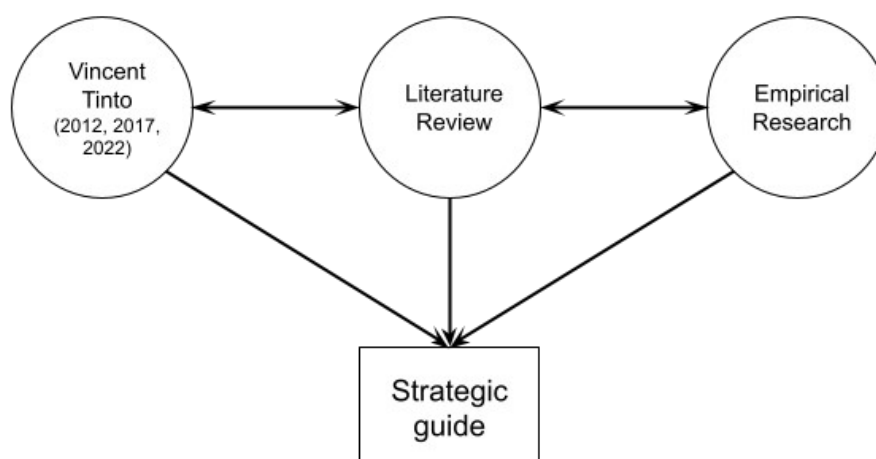
According to Tinto (2022), promoting a sound understanding of curricular relevance requires the formation of a student support team. In the Brazilian context of public universities, this team may be composed of professors, the program coordination, the NDE, and students. Beyond actions geared toward the classroom that seek to make the activities envisaged by the program’s curriculum meaningful, this team can engage in the continual restructuring of the curriculum, addressing institutional, social, and students’ personal demands.

METHODOLOGY

The creation of the guide for combating dropout and fostering persistence in Teaching Degree programs in the Exact Sciences proceeded through the following stages, which are also outlined in Figure 2: 1) study of the theoretical framework; 2) literature review; and 3) empirical research.

Figure 2

Methodology for the construction of the strategic guide



Source: Authors’ own work (2025).

The methodological details and the results of items 2 and 3 can be accessed in full in the first author’s thesis (Silva, 2022a) and in published articles (Carniel & Espinosa, 2024a, 2024b). In addition, it is important to highlight that we also

considered the results of the literature review conducted by Franco et al. (2022), as they identified institutional strategies for combating dropout and promoting student persistence that were not found in our own review. These strategies are consistent with the principles of academic success outlined by Tinto (2012) and include initiatives to value students (support), the promotion of integration activities and the formation of support networks (engagement), and strategies related to expectations and feedback.

The resulting strategic guide (an educational product) includes: i) a brief report on the average profile of students who dropped out of, were enrolled in, and graduated from the program; ii) the identification of the causes of dropout and persistence of these students; and iii) the proposal of 13 strategies to combat dropout and promote persistence, relating them to the causes identified in the literature and in the empirical research, as well as to the constructs described by Vincent Tinto as determinants of dropout. It is worth noting that, in transposing the research findings into the guide, we made certain omissions on the grounds of low frequency/relevance, as well as textual adaptations to make the content accessible to the target audience.

The research, partially described in this article, was approved by the Research Ethics Committee of FURG (CAAE: 50391921.4.0000.5324) on October 14, 2021.

RESULTS AND PRESENTATION OF THE EDUCATIONAL PRODUCT

Based on the analysis of the causes of dropout and persistence, as well as on the identification of strategies for combating dropout and promoting retention, we structured this guide around three fundamental axes: 1) the literature review (Carniel & Espinosa, 2024a); 2) the empirical research conducted with students of the LCE at FURG (Silva, 2022a; Carniel & Espinosa, 2024b); and 3) the studies of Vincent Tinto, which include: a) guidelines for institutional action (Tinto, 2012), b) the Model of Student Motivation for Persistence (Tinto, 2017), and c) guidance on academic, social, and curricular support (Tinto, 2022). Drawing on these sources, it was possible to structure a set of strategies, some already implemented and others that may be incorporated in the future. Table 1 presents a synthesis of the results obtained in stages 1 and 2, highlighting the causes of dropout and the factors of persistence both in the literature and in the reality of the LCE students at FURG.

Table 1

Synthesis of the Literature Review and Empirical Research

Causes of dropout according to the literature	Causes and possible causes of dropout for (former, enrolled, and graduated) LCE students
- Mistaken choice of program - Demotivation and lack of commitment to the program - Desire to pursue another program - Little engagement with the program - Difficulty reconciling study with other activities - Financial difficulties - Location of the HEI - Social inequality	- Lack of interest upon entering the program - Problems identifying with the program and future profession - Entry into the labor market in another field - Financial difficulties - Personal/family reasons

- Teaching methods - Difficulties with course content - Difficulties in the transition to Higher Education - Curricular issues - Academic failure - Criticism of faculty training and/or behavior - Inadequate assessment criteria - Accumulation of activities - Course failures early in the program - Difficulty interacting with peers - Difficulty interacting with faculty - Competitiveness among peers - Low pay and social devaluation of the profession - Personal/family reasons - Lack of family support - Psychological problems - Institutional problems - Lack of information about the program - Poor physical infrastructure of the HEI - Problems with the program - Lack of projects or opportunities to participate	- Difficulty reconciling the program with other activities - Problems with faculty - Difficulty with course content - Lack of time - Pregnancy - Difficulties with ERT (Emergency Remote Teaching) - Psychological problems - Difficulty with the teaching methodologies used
Causes of persistence according to the literature	Causes and possible causes of persistence for (enrolled and graduated) LCE students
- Student identification with the program and future profession - Family support - Desire for a higher education degree - Psychological support - Student aid - Research, teaching, and extension scholarships - Curricular modifications - Faculty support for the student - Teaching with diverse methodologies - Sense of good learning - Interaction with peers - Interaction with faculty - Participation in projects (research, teaching, and extension) - Support for first-year students	- Self-motivation to complete the program - Emergency Remote Teaching - Reducing the number of courses - Identification with the program - Having completed a good part of the program - Enrollment in student aid programs - Support from faculty - Support from peers - Psychological counseling - The opportunity for a better life

Source: Adapted from Silva (2022a).

In accordance with this synthesis, we grouped the identified causes of dropout together with the causes of persistence and obtained the following categories: i) interactions with faculty; ii) interactions with peers; iii) course content; iv) teaching methodologies; v) reconciling the program with other activities; vi) access to information; vii) financial issues; viii) psychological issues; and ix) identification with the program. Based on these categories, as well as on the strategies extracted from the literature and the recommendations of Tinto (2012, 2017, 2022), we developed 13 strategies to reduce dropout and strengthen the persistence of LCE students at FURG, which are presented below.

A welcoming and structured academic environment plays a fundamental role in student retention, preventing conflicts among students and strengthening the relationship between faculty and students (i). Pedagogical attentiveness stands out in this context, since the faculty member's genuine concern for the student's learning and well-being directly impacts the student's retention (Walker & Gleaves,

2016). In addition, our literature review (Carniel & Espinosa et al., 2024a) identified academic self-regulation as an essential factor for student success, highlighted by Frison et al. (2021) as an effective resource for coping with difficulties in curricular content (iii).

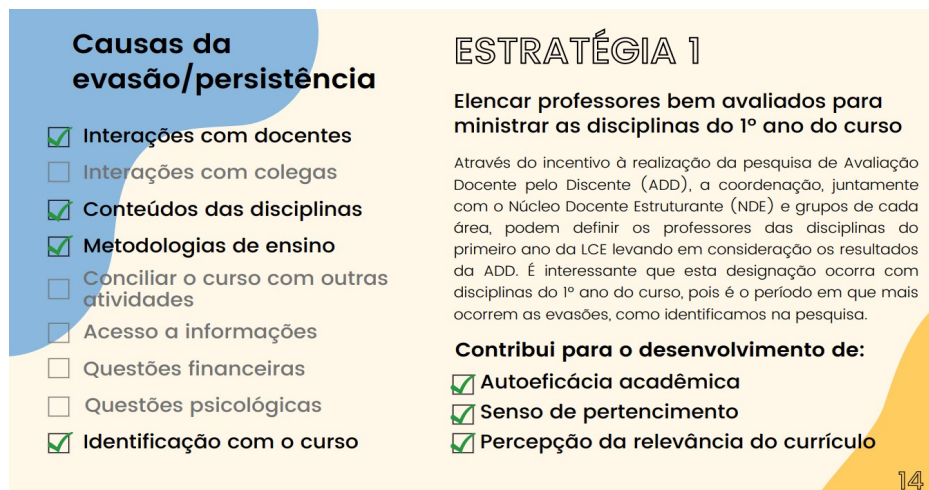
Recent studies (e.g., Franco et al., 2024) indicate a significant relationship between academic persistence and constructs such as self-regulated learning, self-efficacy, sense of belonging, and perception of curricular relevance. The data show that these factors explain 29% of the variation in students' intention to persist, highlighting the need for institutional strategies that promote the development of these skills. Self-regulation can be developed autonomously by students, but it can also be encouraged by faculty through practices that foster academic autonomy.

With the aim of enhancing pedagogical attentiveness and promoting the development of faculty-fostered academic self-regulation, we recommend the following strategies in the guide: **assigning well-evaluated faculty to teach the first-year courses of the program (Strategy 1)** and **considering faculty with a doctorate in Teaching/Education to teach first-year courses (Strategy 2)**. To select well-evaluated faculty, we suggest that, by encouraging the administration of the Student Evaluation of Teaching (*Avaliação Docente pelo Discente*—ADD) survey, the program coordination, together with the NDE and the groups from each field, can designate the faculty for the first-year LCE courses while taking the ADD results into account. In addition to having faculty with a Doctorate in Teaching/Education teach the Education and Teaching courses in the first year of the program, we suggest that they also be considered to teach the Exact Sciences courses, in accordance with their academic training. It is advisable for these designations to apply to first-year courses, as this is the period in which dropouts most often occur (e.g., Silva, 2022a; Ribeiro & Morais, 2020).

Figure 3 illustrates Strategy 1 as presented in the strategic guide, highlighting its contribution to minimizing dropout factors and strengthening aspects such as academic self-efficacy, sense of belonging, and perception of curricular relevance.

Figure 3

Strategy 1 of the Strategic Guide for Combating Dropout and Fostering Persistence in Teaching Degree Programs in the Exact Sciences¹



Source: Silva (2022b).

Thus, Strategy 1 has the potential to act directly on the challenges related to interaction with faculty (i), course content (iii), teaching methodologies (iv), and identification with the program (ix). In addition, we also indicate its potential to increase academic self-efficacy, sense of belonging, and perception of curricular relevance. Similarly, Strategy 2 also impacts these aspects, reinforcing its importance for student retention.

Beyond institutional initiatives, strategies that promote academic self-regulation arising from the students themselves are essential. To this end, we developed Strategy 4, which proposes **creating actions to guide students on study organization and time management**. Lectures and meetings promoted by the team (including its psychologist) of the Dean's Office for Student Affairs (*Pró-Reitoria de Assuntos Estudantis*—PRAE) can offer practical guidance on these matters, helping to minimize difficulties related to course content (iii) and to reconciling the program with other activities (v), and to foster academic self-efficacy.

Although some of these actions are already being implemented at FURG, we found that there are few systematic records of them, and they could be implemented more decisively through projects. We therefore suggest the creation of institutional projects that strengthen such initiatives, considering metacognitive strategies used by higher education students, such as learning monitoring, planning and time management, and the evaluation/adjustment of strategies (Leal, 2023). Furthermore, we emphasize that Strategy 7, related to academic mentoring, can complement these initiatives by assisting first-year students with organization and time management.

In addition to pedagogical attentiveness, having a faculty advisor can create bonds of companionship and friendship between faculty members and students (i) (Silva, 2019; Pereira et al., 2015; Andriola, Andriola & Moura, 2006). On this basis, we developed Strategy 3 of the guide: **assigning faculty advisors to incoming students**. This strategy can be implemented during the *Acolhida Cidadã*, an event

promoted by FURG at the beginning of the semester to welcome first-year students (FURG, 2025a). The expectation is that this initiative will increase students' sense of belonging and perception of curricular relevance.

About interaction between senior and first-year students (ii), we propose Strategy 7: **implementing the Academic Mentorship Program** (*Programa de Apadrinhamento Acadêmico*). This program, which has already taken place at FURG, aimed to assist incoming students in adapting to and integrating into the university environment and the new academic routine (Valente, 2015). Through this program, each first-year student would be guided by a volunteer senior student (mentor). In addition to promoting interaction among peers (ii), this strategy can act on difficulties related to courses (iii), access to information (vi), and identification with the program (ix).

According to Tinto (2022), mentorship programs are fundamental for offering social support to students, as well as curricular support when the mentor guides the student in that context. In line with this perspective, Calsing and Heidemann (2023) investigated the impacts of the actions promoted by a mentorship program (academic mentoring) in the Physics Teaching program at the Federal University of Rio Grande do Sul (UFRGS). The results of that research indicate that the mentoring had significant impacts, as it: improved first-year students' self-efficacy beliefs by assisting them with tasks, providing study materials, and creating supportive environments; strengthened the sense of belonging by facilitating interaction with peers and promoting participation in program events; and generated a positive perception of curricular relevance by highlighting the importance of courses and sharing experiences, fostering greater identification with the institution and the program (Calsing & Heidemann, 2023). These results reinforce the importance of the strategies presented in the guide, which were formulated based on academic literature and the institution's prior experience.

The difficulty in keeping up with courses (iii), especially those in the Exact Sciences, can be minimized through the introduction of introductory, remedial courses (e.g., Micha et al., 2018) or courses that build identification with the program (e.g., Heidemann et al., 2020), as well as through the adoption of active teaching methods (Vázquez-Alonso & Manassero-Mas, 2016; Moraes et al., 2020; Vilela et al., 2020).

Considering these strategies set out above, we developed the following strategies in the guide: **including remedial and identity-building courses in the program (Strategy 5)** and **implementing active teaching methods (Strategy 6)**. Drawing on the experience of introducing a new course, regarded as introductory, in the Physics Teaching program at UFRGS— "Introduction to Physics"—we can say that the objectives that characterize it as an introductory course are to foster:

[...] students' motivation to persist through the construction of self-efficacy beliefs, senses of belonging, and more positive perceptions of the curriculum. To achieve this objective, the following specific objectives were outlined: enabling teaching-degree students to reflect on the role of science education and the nature of Science [and Mathematics], allowing them to construct an identity grounded in a conception of Physics [Exact Sciences] teaching geared toward the construction of critical thinking, distancing themselves from technical-rationalist views of teaching work, in which the teacher supposedly transmits knowledge constructed in contexts disconnected from basic schooling; fostering the construction of collaborative bonds among students, promoting the construction of unity among teaching-degree students, which will influence their social and academic

integration; enabling students to construct meaning for the concepts of Physics[, Chemistry,] and Mathematics addressed in secondary school, favoring the construction of competencies for tackling problems in basic Physics[, Chemistry, and Mathematics] and the mitigation of formative deficiencies from Basic Education; and promoting situations that enable students to construct relationships between scientific theories and reality, understanding the representational nature of scientific knowledge (Heidemann et al., 2020, p. 170, our adaptations and translation).

This approach shows that a pre-calculus course, on its own, may not be sufficient to bridge formative gaps. And, even though it is not so evident in this specific case, identification with the teaching profession is highlighted in the literature as crucial for retention (e.g., Paz & Lima, 2022). In this strategy (5), we highlight its potential to mitigate factors associated with dropout and to strengthen academic retention, addressing difficulties related to course content (iii), teaching methodologies (iv), and identification with the program (ix). Moreover, this and other strategies (1, 2, and 5) share the common objective of making the transition to university smoother by providing adequate academic support. According to Tinto (2022), this support needs to be directed to the student's area of study, adapting to the specific demands of the program, especially in the initial period of academic training.

Several studies show that the **adoption of active methods in Science Teaching (Strategy 6)** can contribute to increasing student attendance, reducing failure rates, and improving performance on conceptual tests, thereby resulting in greater academic persistence (e.g., Franco, 2019; Moraes et al., 2020). However, to maximize their effects, it is advisable that the faculty members not completely replace traditional methods, but rather adopt a hybrid approach, combining active and traditional strategies. This practice can positively impact factors associated with dropout and student retention, especially regarding course content (iii), teaching methodologies (iv), and identification with the program (ix), as well as having potential to impact the student's academic self-efficacy.

As for financial issues (vii) and the need to reconcile studies with work (v), it is essential to expand the offer of scholarships and student aid, as discussed by Tinto (2012) in defining financial support as an essential factor for retention. In this regard, the guide proposes the following strategies: **maintaining (or expanding) the offer of Research, Teaching, and Extension projects (Strategy 12)** and **maintaining (or expanding) the offer of scholarships and student aid (Strategy 13)**.

The results of the empirical research indicate that participation in academic projects is an effective strategy for fostering persistence, as it provides financial support to students (Silva, 2022a). Furthermore, such projects favor identification with the program (ix), broaden training beyond the classroom, and offer opportunities for teaching experience, especially within the Institutional Program of Teaching Initiation Scholarships (*Programa Institucional de Bolsas de Iniciação à Docência—Pibid*) and the Pedagogical Residency (*Residência Pedagógica—RP*), a finding also observed in the literature (e.g., Evangelho et al., 2019). In addition to strengthening identification with the program, Strategy 12 also promotes interaction with faculty (i) and peers (ii), as well as impacting students' self-efficacy, sense of belonging, and perception of curricular relevance. Strategy 13, in turn, helps to minimize the challenges related to the need to reconcile the program with other activities (v), allowing the student to devote themselves fully to their

undergraduate studies. Moreover, by enabling greater retention at the university and opportunities for teaching experience, these strategies can strengthen students' sense of belonging (Tinto, 2022).

In addition, on the campus there is a wide offer of participation in Research, Teaching, and Extension projects, whether as a scholarship holder or a volunteer, notably the Tutorial Education Program (*Programa de Educação Tutorial—PET*) and Pibid, the latter being geared exclusively toward the Teaching Degree in Exact Sciences (LCE). Beyond these initiatives, since 2016 the institution has held the program's Academic Week, an event that gives students the opportunity to learn more about the profession through lectures and activities with guests external to the university.

Another aspect identified in the empirical research concerns the urgency of changing the program's schedule (time of day) (Silva, 2022a; Carniel & Espinosa, 2024b). However, it is important to emphasize that, although adjusting the schedule is a frequent demand, this change, on its own, does not guarantee student retention. Evidence of this is that some students who pointed to the need to change the schedule ended up dropping out and migrating to programs in different fields or to the Distance Education modality after leaving the LCE at FURG (Silva, 2022a). In addition, the research found that the program's course load was not concentrated in a single part of the day, resulting in classes spread throughout the entire day. This factor made it difficult to reconcile the program with other activities (v) and was one of the most frequently mentioned reasons for dropout (Silva, 2022a; Carniel & Espinosa, 2024b). To mitigate this problem, the program underwent a curricular restructuring and, as of 2023, came to be offered in the evening.

This change aligns with curricular reorganization strategies widely discussed in the literature (e.g., Vázquez-Alonso & Manassero-Mas, 2016; Andriola et al., 2006; Micha et al., 2018; Moraes et al., 2020). On this basis, the guide proposes the following strategy: **concentrating on the program's courses in the same part of the day (Strategy 8)**. This measure can contribute to student retention by making it easier to reconcile the program with other activities (v) and by strengthening identification with the undergraduate program (ix). In addition, it has the potential to positively impact students' sense of belonging and perception of curricular relevance.

About psychological support (viii), this is made available by PRAE through the National Student Assistance Program (*Programa Nacional de Assistência Estudantil—PNAES*). However, this service generally occurs only when the students themselves request it. According to information available on the FURG website, the School Psychology service seeks to assist the teaching and learning process in the various educational settings, including the university (FURG, 2025c). Its actions involve processes of inclusion and accessibility, advising staff, conducting collective interventions in the university context, as well as offering spaces for listening, dialogue, and the promotion of mental health, with a focus on the demands of everyday academic life (FURG, 2025c).

Specifically, at the FURG SAP campus, we identified the existence of the MUDEI project, which uses photography and writing as tools to support incoming students. The initiative seeks to promote cultural exchanges and experiences,

strengthening the bond between students and the university (FURG, 2025b). Given that psychological care at the institution occurs predominantly on demand, we suggest the following strategy in the guide: **expanding mental health awareness activities (Strategy 11)**. This strategy provides lectures, meetings, and other activities with students and faculty, aimed at raising awareness of the importance of caring for mental health and clarifying how to access the services offered by the university.

Empirical research (Silva, 2022a) also indicated that the lack of information (vi) can compromise students' sense of belonging to the program and the institution. To mitigate this problem, we propose the following strategy: **holding periodic meetings with students and encouraging gatherings among students (Strategy 9)**. These meetings, involving the program coordination, the NDE, and students, should provide an open space for dialogue and for clarifying doubts. We believe that this strategy can help to improve interaction between students and faculty (i), strengthen relationships among peers (ii), facilitate access to information (vi), and reinforce identification with the program (ix).

Also, with the aim of fostering identification with the program (ix), promoting greater familiarity with its content (iii), and ensuring easier access to information (vi), we suggest the following strategy: **creating online spaces for disseminating the program's actions, science communication, and other matters related to the Exact Sciences (Strategy 10)**. The proposal involves frequently updating the LCE-FURG website and creating institutional profiles on social media, taking as references successful initiatives such as the Instagram accounts @unipampa.fisica and @if.ufrgs/@cref.ufrgs.

The strategies included in the guide were organized based on their perceived relevance in empirical research and in literature. However, we recognize that the implementation of these actions may vary in terms of feasibility and institutional dependence. For example, the adoption of active teaching methods depends largely on the individual willingness of faculty members, with the coordination and the NDE responsible for encouraging them and offering opportunities for continuing professional development. On the other hand, strategies such as holding periodic meetings with students and promoting gatherings among students are more readily feasible, as they require only an organizational effort on the part of the coordination, the NDE, or the faculty members themselves.

Finally, we highlight that Strategies 11, 12, and 13 were included in the guide owing to their high relevance, as indicated in empirical research. Although they are already practicing at FURG, enrolled and graduated students greatly value the possibility of more active participation in the university, strengthening the sense of academic belonging. Furthermore, we emphasize that, although they are directed at the LCE at FURG, these strategies can be adapted to similar programs if necessary.

FINAL CONSIDERATIONS

Based on the creation of strategies grounded in the literature, in Vincent Tinto's theoretical framework on student persistence, and in the empirical research conducted with the LCE students at FURG, we believe that the guide can

contribute significantly to reducing dropout and strengthening academic retention. The expected impact occurs through the strengthening of students' self-efficacy beliefs, sense of belonging, and perception of curricular relevance, both for the LCE and for programs with similar characteristics. In addition, we recognize that factors such as academic self-regulation and pedagogical attentiveness play an essential role in promoting student retention.

The strategies presented demand a joint effort from the institution, faculty, coordinators, and students, requiring a continuous commitment to ensure their long-term sustainability. The implementation of active teaching methodologies, the expansion of the offer of scholarships and student aid, the concentration of courses in a single part of the day, the promotion of actions aimed at mental health, and the strengthening of interactions between students and faculty are some of the measures that show potential for mitigating the factors that contribute to dropout. Furthermore, the creation of spaces for communication and transparency, such as periodic meetings and online platforms for disseminating information about the program, can foster student engagement, strengthening their identification with the university.

The guide should not be seen as a static document, but as a starting point for the implementation of concrete actions that improve students' academic and social experiences. Its strategies can and should be adapted to the specificities of each program and institution, taking contextual and cultural particularities into account. In addition, it is advisable that, during and after its implementation, studies be conducted to assess its applicability and effectiveness. Analyzing the impact of the actions on dropout and persistence rates, as well as on the development of attitudes favorable to change among students and faculty, will allow adjustments that optimize the effectiveness of the initiatives.

More than a set of strategies, this guide represents a commitment to student retention and success, reinforcing that education only transforms lives when accompanied by intentional, continuous, and collective actions. In this way, we hope that the proposed actions will not only reduce dropout rates but also contribute to the training of professionals who are better prepared and more committed to their fields of work.

NOTES

1. Figure 3 reproduces page 14 of the strategic guide (Silva, 2022b), which presents Strategy 1. On the left, under the heading “Causes of dropout/persistence,” a checklist marks the categories the strategy is intended to address: interactions with faculty, course content, teaching methodologies, and identification with the program are checked, whereas interactions with peers, reconciling the program with other activities, access to information, financial issues, and psychological issues are left unchecked. On the right, under the heading “Strategy 1,” the guide states the strategy—assigning well-evaluated faculty to teach the first-year courses—and explains that, by encouraging the administration of the Student Evaluation of Teaching (ADD) survey, the program coordination, together with the NDE and the groups from each field, can designate the faculty for the first-year LCE courses on the basis of the ADD results; it notes that these designations should apply to first-year courses, since this is the period in which dropouts most often occur, as identified in the research. A final section, “Contributes to the development of,” indicates with check marks that the strategy fosters academic self-efficacy, sense of belonging, and perception of curricular relevance.

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