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DIGITAL TOOLS FOR THE PREVENTION OF DROPOUT AND ACADEMIC FAILURE: A CASE STUDY OF A PORTUGUESE UNIVERSITY

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Abstract

Concern for the academic success of an increasingly diverse student body is receiving greater national and global attention in higher education. Given the increasing demands and evolving challenges that students now face, higher education institutions are called upon to develop multifaceted solutions that allow for the identification and prevention of academic pathways that may put their students at risk of failing or dropping out. This paper presents the results of a trial carried out at a Portuguese public University concerning the development of digital tools, using machine learning models to help bolster efforts aimed at mitigating the risk of dropout and failure in higher education. From the outset, this trial has been built on interdisciplinary cooperation between specialists within the social sciences, information systems and information technology as well as between teachers, students and various university departments (Academic Administration, Social Services, Soft Skills Lab, Pedagogical Council, Computer Science, Information Systems and Quality Management). The creation of these tools is mainly based on the definition and implementation of an internal information system (FenixEdu) currently in the testing phase. Implementation has followed a multi-stage process guided by the following objectives and procedures: a) defining success and dropout indicators in accordance with national and international guidelines; b) identifying the scale of the problem within the institution; c) understanding the patterns of the problem under study; d) identifying critical factors of failure and dropout; e) to implement a digital alarm system that contributes to preventive action and improves conditions for success, especially focused on students who are at risk of failure or dropout. It is expected that such a system will automatically identify pathways to both success and failure, enabling accurate and comprehensive analysis of students' academic data, including patterns and key indicators that can be used to predict risks of failure, while enabling proactive and personalized interventions to improve performance and maximize opportunities for academic success.

Keywords: alarm systems, machine learning models; dropout, higher education.

INTRODUCTION

OBJECTIVES AND THE PATH TO AN ACTION RESEARCH PROCESS

This paper shares the experience conducted at a Public University in Portugal in developing digital tools to monitor academic success and dropout, supported by the use of machine learning models, in alignment and reinforcement of actions that seek to mitigate the risk of failure and dropout in higher education. From the outset, this process was built on interdisciplinary dialogue between social sciences and the areas of information systems and technologies, and in articulation between teachers, students and various university services (Academic Administration, Social Services, Soft Skills Lab, Pedagogical Council, Informatics and Information Systems and Quality Management).

The design of the reference tools has as its main substantive basis in the definition and implementation process of an internal information system (FenixEdu) and is currently in the pilot phase. Its implementation has followed a multi-step process guided by the following objectives and procedures: a) defining success and dropout indicators that are aligned with national and international guidelines for this purpose; b) identifying the dimension of the problem under study in the institution; c) understanding the patterns of the problem under study; d) signaling critical factors in explaining

(in)success and dropout; e) implementing a digital alarm system that provides contributions to preventive action and improvement of success conditions and with a focus on students in a situation or at risk of failure and dropout.

It is expected that the use of such a system, structured based on key indicators, will automatically provide and identify paths to academic success or failure in real-time, enabling accurate and comprehensive analysis of students' academic data. The information thus produced will enable interventions based on validated and personalized information, aimed at improving performance and maximizing opportunities for academic success.

THEORETICAL FRAMEWORK

This project aims to develop tools for the prevention and alerting of situations at risk of university dropout and to support the design of action strategies at the institutional level aimed at improving students' academic success.

The project takes as its starting point the results of research that has identified the social characteristics, trajectories and challenges posed by reception and integration into higher education [1, 2, 3, 4, 5, 6, 7]. The diagnoses and findings produced in these studies are further complemented by the analysis of public policies in this sector [5, 8].

Some of this research has been carried out concerning the institutional framework of Iscte-Instituto Universitário de Lisboa, the public university that serves as the observational reference for the project [9, 10, 6]. These previous studies have allowed us to analyze and consolidate knowledge of the challenges posed within the relational framework of the Iscte student community and to determine which components, tools, and methodologies already created will be useful in developing the global monitoring and alarm system.

In particular, the accumulated knowledge, together with the consolidated experience in monitoring students' academic results and pathways, allows us to conclude that the first year of a degree is particularly critical in terms of failure and dropout rates [11, 6]. This has supported the option, in the current pilot phase of this project, to retain that academic/curricular year as the focus for planning and implementing the various procedures underlying a digital alarm system.

In addition, when selecting and systematizing information on this segment of students enrolled in the 1st year for the first time, special attention is also paid to groups that are traditionally under-represented or with identified difficulties in integration into higher education: students displaced from their usual residence for study reasons; students from priority/special contingents - with emphasis on students with disabilities; students who receive social action scholarships; students who are nationals of Portuguese-speaking African countries (PALOP); working students, among others [7,12].

Currently, institutional information systems are an essential, powerful tool with the potential to update and recognize very relevant dynamics. The associated data makes it possible to respond to analytical models with indicators and to be a complementary aid for intervention (namely with the creation of alarms statistics) within the framework of the study of academic success, as observed in [11] [13] [10] [6] [14]. However, these tools also pose a set of challenges to their use: a targeted intervention may compromise anonymization; the management of data in real time and with the anticipation that allows for timely preventive action; the limits and diversity of indicators on these platforms, in the face of data that are collected for administrative management purposes, often dissociated from the uses intended in this project.

OPERATIONALIZATION

At Iscte, all academic information resides entirely in the FenixEdu system, which is the database that informs this study. The wealth of data generated by this system is an important source of information. However, the data is not always adequately aggregated to meet the academic progress objectives, and sometimes collecting it is a challenge.

The implementation of the alarm system was carried out in successive stages:

- 1) *Identification and selection of a set of relevant indicators*: These indicators should consider the characteristics and dimensions of the problem in focus.
- 2) *Storage and encryption of the data*: This includes defining who can handle the information and establishing specific conditions of use.
- 3) *Information extraction, analysis, and aggregation*: This is done with a view to the nominal identification of students at risk.
- 4) *Mapping of available resources and services*: This is done to trigger communication with the students.

5) *Promotion of different forms of action*: This is done through negotiated processes with the student-actor-receiver. This will involve mobilizing peers (mentors) from the student body; class teachers (tutors; 1st year coordinators and course directors; and the various pedagogical, social services, and academic administration services of the institution.

PILOT PROJECT

In the initial phase of this pilot project, given the timeframe in which it took place, a specific population of students was analyzed to establish a guideline for the concepts and indicators to be considered when implementing the system for alarming and preventing academic failure and dropout.

The selected population consists of first-year undergraduate students entering Iscte for the first time. The information collected (during the month of March 2024) focuses on data from the 1st semester of the 2023/2024 academic year and includes sociodemographic characteristics, special statuses, and other relevant elements of the academic career. Specifically, the operationalized indicators consist of the following:

- Nationality (and second nationality, if applicable)
- City and Country of Residence (of the family and of the student during the academic term, if different)
- Course information
- Entry regime (General Quota, Special Quotas).
- National Entrance Exam entry stage.
- Class attendance regime (Full-time/Part-time)
- Enrolled ECTS (and nominal list of Curricular Units) in the reference semester.
- Completed ECTS (and nominal list of Curricular Units) in the reference semester.
- Status (International, Scholarship holder, Working Student, SEN, etc.).
- Withdrawal requests.
- Indication of whether the student owes tuition fees.

In addition to the information initially collected and indicated above, it was also possible to gauge additional information by constructing derived indicators, which allow for a more precise delimitation of key segments and dimensions of the target population:

- *Indication of whether the student is displaced*:
 - The student's home or term-time residence is located more than 45 km from the educational institution they attend.
 - The student was admitted through the Islands, International or PALOP contingent.
- *Ratio of Completed ECTS to Enrolled ECTS*
- *NA ratio (Not Assessed)*:
 - Ratio between ECTS with NA (student was not assessed in the course unit) and Enrolled ECTS. Example: a student with NA Ratio = 1.0 means that he/she has not been assessed in any of the curricular units in which he/she was enrolled.

Identification of Students at Risk

Based on previous studies on this topic of academic failure at Iscte [9, 15, 16, 17] it was possible to ascertain which axes were most relevant when analyzing this type of information. To this end, it was decided to define a set of indicators that would make it possible to assess which students needed institutionalized intervention by specific university teams. For this purpose, harmonized criteria were defined for flagging students at risk:

- Students with a percentage of completed ECTS/enrolled ECTS below 50%;
- Scholarship students who have completed less than 18 ECTS in the semester (at risk of losing their scholarship in the following academic year);
- Students who have applied for withdrawal.

Personalized Intervention Plans

The set of flagged students is then analyzed on a case-by-case basis to define personalized intervention plans. These are established in a negotiated dialogue with the targeted students and the services

appointed to follow them up, based on the results obtained in the initial screening process of the specific situation of the student.

RESULTS

In this initial phase of the project, in which the indicators mentioned above were applied, it was possible to ascertain a set of results that helped diagnose experiences of academic failure that tend to lead to students dropping out of university.

The results show that around 19 percent (n=361) of all 1st year students need specific intervention. Of these flagged students, the overwhelming majority (98%; n=354) have an completed ECTS/enrolled ECTS ratio below 50%. Even more worryingly, 58% of the flagged students (n=211; 11% of all 1st-year students) didn't complete any ECTS in the first semester and nearly 22% (n=79; 4% of all 1st-year students) formalized a withdrawal request.

At-risk groups dimension:

- 211 students with zero completed ECTS (11.2%)
- 354 signaled (18.8%)
- 25 grantees with <18 ECTS completed (1.3% of all students, 9.5% of all grantees)
- 79 students who request to withdraw (4.2%)
- A total of 361 students to intervene (19.2%)

Contacts made with students who have formalized a withdrawal request have confirmed that the main reason is related to a change of degree/institution and the fact that they did not enter the degree of their first choice. Another relevant situation is the difficulty in securing the financial costs associated with accommodation, in a context where the supply of student residences at controlled prices is far from meeting the needs [18].

The comparison between R0 (ratio of students with zero completed ECTS) and R-NA1 (students not assessed in any course) shows that more than $\frac{3}{4}$ of students with zero completed ECTS in the 1st semester did not take any assessment.

Table 1 highlights some variations in the incidence of risk of dropout and academic failure according to student status.

International students stand out among the most at-risk groups. A significant portion of these students (almost $\frac{3}{4}$) come from Portuguese-speaking African countries (PALOP). It should be noted that some PALOP students are not formally classified in the system as "international students" - their admission to the University took place under cooperation agreements between Portugal and PALOP countries. However, they face specific difficulties, both in terms of cultural and linguistic contrast and educational background, as well as socio-economic integration challenges [12]. Additionally, due to visa difficulties, many of these students tend to arrive in Portugal very late, often after the first semester's classes and assessments have been completed, and therefore end up registering late [20].

Among the segments with greater challenges, we also find students who attend the post-work training offer (after 6 pm). The age profile of these students is concentrated in the ages above 20, and particularly in the age groups 20-29 years; 30-39 years and 40-50 years, which, as can be seen in Table 1, are associated with increasing academic success challenges. Many of these students tend to combine study activities with paid work - although this is sometimes not reflected in access to the status of working students, due to the lack of a stable and contractual employment situation. In addition to the need to reconcile study and work activities, it is also in these age groups that we find a greater presence of those who have school-aged children.

Students with special educational needs, although in different proportions from the previous segments, also have a less favorable R0 ratio, but in this case a significant part of the failure is related to non-approval in the Courses in which they are enrolled.

Overall, these findings highlight the importance of considering the specific challenges faced by these groups when designing intervention strategies.

Table 1 also presents contrasting situations to those mentioned earlier: students who show higher rates of success and integration. This is the case of class representatives; those who dropped out of their first enrolment and entered a new course; and students who receive social action scholarships.

The reasons behind these more successful profiles are diverse: In addition to opportunities inherent to the social conditions of these students, as well as their greater or lesser academic excellence

throughout their educational career, study habits and time management skill; student resilience and determination; access to financial support or/and academic guidance are factors that help explain this differentiated performance.

CONCLUSION

The application of machine learning systems for identifying critical situations related to students' academic performance and early dropout risk holds great potential [6, 9, 10, 13, 14]. This pilot system, implemented through a multi-stage process involving a multidisciplinary team, demonstrates the value of leveraging administrative data for action [15, 16, 17, 18]. The procedures that have been followed in its design and implementation are, in themselves, an example of a process of action for action that takes advantage of the administrative data available in the university's academic management system. The selection of significant indicators for the alarm system was based on extensive research on student dropout, academic success, and effective intervention strategies [5, 7, 8, 9, 12, 18]. The system's results have supported actions to improve reception and monitoring for identified students, who are contacted by a dedicated support team. Among the university's implemented actions are: 1) forming a mentor team (students from diverse academic backgrounds) supported by representatives from various services; 2) organizing health and well-being workshops; 3) expanding training in transversal skills to help students develop effective study habits and academic success strategies, particularly for PALOP students integrating into a technology-driven community; 4) providing pedagogical innovation training for teaching staff; 5) creating a "student space" with representatives from various services; and 6) establishing a monthly routine for meetings and discussions among service representatives, student representatives, and teaching staff from different disciplines.

TAB 1 - INCIDENCE OF RISK OF DROPOUT AND ACADEMIC FAILURE BY STUDENT STATUS & CHARACTERISTICS

Student Status & Characteristics	N	R0	%R0	R0-0.5	%R0-0.5	RNA1	%RNA1	RNA0.5-1	%RNA0.5-1
Internacional Students	72	26	36.11%	24	33.33%	22	30.56%	14	19.44%
Internacional Students - Refugees	14	6	42.86%	5	35.71%	4	28.57%	3	21.43%
Students from Portuguese-speaking African countries	91	39	42.86%	28	30.77%	26	28.57%	15	16.48%
Displaced students	249	63	25.30%	53	21.29%	45	18.07%	29	11.65%
Late enrolment students	71	19	26.76%	7	9.86%	15	21.13%	5	7.04%
Students with special educational needs	14	2	14.29%	0	0.00%	1	7.14%	1	7.14%
Students enrolled in after-school courses	221	24	10.86%	15	6.79%	19	8.60%	13	5.88%
Working students	123	9	7.32%	15	12.20%	6	4.88%	8	6.50%
Students receiving state grants	264	10	3.79%	9	3.41%	9	3.41%	5	1.89%
Student transferred to a new course	42	1	2.38%	2	4.76%	1	2.38%	2	4.76%
Class representative	60	1	1.67%	1	1.67%	1	1.67%	0	0.00%
Age groups									
<20y	1375	106	7.71%	78	5.67%	75	5.45%	56	4.07%
20-29y	406	74	18.23%	55	13.55%	63	15.52%	31	7.64%
30-39y	47	16	34.04%	8	17.02%	14	29.79%	4	8.51%
40-50y	40	12	30.00%	3	7.50%	9	22.50%	3	7.50%
>50y	15	1	6.67%	1	6.67%	1	6.67%	1	6.67%
All students	1883	209	11.10%	145	7.70%	162	8.60%	95	5.05%

Legend:

R0 = Ratio of ECTS Completed / ECTS Enrolled= 0%.

R0-50 = Ratio of ECTS Completed / ECTS Enrolled> 0% e < 50%.

R<50 = (R0 + R0-50); R-NA1 = Ratio NA = 100%.

R-NA1= Ratio NA = 100%: Student who did not attend any assessment in the curricular units in which he/she was enrolled.

RNA0.5-1: Ratio NA < 100% e > 50%.

REFERENCES

- [1] A. F. Costa & J.T. Lopes, "The diverse pathways of higher education students: a sociological analysis on inequality, context and agency", *Portuguese Journal of Social Science*, 10, 1, 43-58, 2011. <http://hdl.handle.net/10071/10083>.
- [2] L. S. Almeida, M.A. Guisande, J. Paisana, "Extra-curricular involvement, academic adjustment and achievement in higher education: a study of Portuguese students", *Anales de Psicología*, 28, 3), 860-865, 2012. <https://hdl.handle.net/1822/21199>.
- [3] A.F. Costa, J. T. Lopes, e A. Caetano (orgs), *Percursos de Estudantes no Ensino Superior: Fatores e Processos de Sucesso e Insucesso (Student Pathways in Higher Education: Factors and Processes of Success and Failure)*, Lisbon, Mundos Sociais, 2014.
- [4] J. Cerdeira, Predictors of student success: a study of Portuguese Higher Education graduates, the NOVA - School of Business and Economics, 2015. https://run.unl.pt/bitstream/10362/15078/1/Cerdeira_2015.pdf
- [5] S. C. Martins, H. Carvalho, P. Ávila, A. F. Costa, Policies for widening participation and success factors in Portuguese higher education, *Creative Education*, 8, 2, 2017. <http://hdl.handle.net/10071/13279>.
- [6] P. D. Gil, S. C. Martins, S. Moro, J. M. Costa, "A data-driven approach to predict first-year students' academic success in higher education institutions", *Education and Information Technologies*, 2021. DOI: 10.1007/s10639-020-10346-6.
- [7] S. C. Martins, R. Mauritti, B. Machado, "How has the pandemic affected access and the feeling of belonging in Portuguese higher education?" *Education Sciences*, 12, 942, 2023. <https://doi.org/10.3390/educsci13090942>
- [8] M.L. Rodrigues & M. Heitor et al (orgs.), *40 Anos de Políticas de Ciência e de Ensino Superior (40 Years of Science and Higher Education Policies)*, Lisbon, Almedina, 2015.
- [9] S.C. Martins, P. Ramos, M. Vicente, H. Miguel, S. Moro & P. Gil, *Reduzir o insucesso e o abandono no Iscte: Uma proposta de estudo a partir do sistema de informação interna, Fénix (Reducing failure and dropout rates at ISCTE: A study proposal based on the internal information system - Fenixx)*, Lisbon, Iscte, 2020.
- [10] Miguel e outros, 2020 H. Miguel, P. Ramos, S. C. Martins, J. M. Costa, Provision of academic data for research: a step for academic success, *Education for Information*, 36, 4, 2020. <http://hdl.handle.net/10071/20652>.
- [11] E. E. Ketonen, A. Haarala-Muhonen, L. Hirsto, J.J. Hänninen, K. Wähälä, & K. Lonka, Am I in the right place? Academic engagement and study success during the first years at university. *Learning and Individual Differences*, 51, 141–148, 2016.
- [12] A.R. Matias (Coord.), P. F. Pinto, V. Rodrigues, P. Martins, T. Seabra et al., *Trovoada de ideias: Inclusão linguística e social dos estudantes internacionais dos PALOP no ensino superior português (Brainstorming Inclusion: Linguistic and Social Inclusion of PALOP International Students in Portuguese Higher Education)*. Coleção Estudos, 76. OM/ACM, 2023.
- [13] R. Asif, A. Merceron, S.A. Ali, & N. Haider, analyzing undergraduate students' performance using educational data mining, *Computers & Education*, 113, 177–194, 2017.
- [14] V. Realinho, J. Machado, L. Baptista, M.V. Martins, "Predicting Student Dropout and Academic Success", *Data*, 7, 146, 2022. <https://doi.org/10.3390/data7110146>.
- [15] P. Gil, "Unfolding the Drives for Academic Success: the Case of Iscte-IUL". *M.Sc. Dissertation*, Iscte – Instituto Universitário de Lisboa, 2019. In: <http://hdl.handle.net/10071/20069>.
- [16] H. Miguel, "Provision of Academic Data for Research: a Step for Academic Success". *M.Sc. Dissertation*, Iscte – Instituto Universitário de Lisboa, 2019. In: <http://hdl.handle.net/10071/20124>
- [17] N. Carvalho, "Student Data Prediction", *M.Sc. Dissertation*, Iscte – Instituto Universitário de Lisboa, 2021. <http://hdl.handle.net/10071/24109>
- [18] R. Mauritti (coord.), A. Paio, C. Sousa, E. Justino, , H. Belchior-Rocha, R.V. Assis, S. Saleiro, S.F. Silva, S. Pintassilgo, Analyse and evaluate the quality of students halls of residences: Final Report), CIES-Iscte, Agência Nacional para a Gestão do Programa Erasmus+ Educação e Formação (AN ERASMUS+ EF), 2023.
- [20] R. Mauritti, S. Pintassilgo, H. Belchior-Rocha, S.P. Saleiro, J. Mendes, "International mobility for study purposes: flows and distribution of CPLP students in higher education and Portuguese territory", *Cidades, Mobilidades e Territórios*, 47, Dez. 2023. <https://journals.openedition.org/cidades/8179>.
- [21] A. Coulon, Le métier d'étudiant: l'entrée dans la vie universitaire, *Educ. Pesqui.*, 43, 44, 2017. <https://www.scielo.br/j/ep/a/Y8zKhQs4W7NYgbCtzYRP4Tb/?format=pdf&lang=fr>.