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Provision of Academic Data for Research:
A Step for Academic Success

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Abstract

One of the most widely researched questions about higher education focuses on exposing paths that lead to academic success. This dissertation provides a tool aligned with the scientific contributions to the concept of success in higher education, as well as the implementation of a system capable of automatic generation of SQL queries based on high level constraints. It includes the use of students' data contained in the ISCTE-IUL University Fénix system in a web application, to assist analyzes and researches. Providing relevant data for consultation can offer a differentiated explanation of the pathways of success in higher education and identify problems and failures to support more effective intervention measures later.

Keywords – Higher education, academic success, information systems, data presentation, web application.

Resumo

Uma das questões mais discutidas sobre ensino superior foca a descoberta de caminhos e padrões que levem ao sucesso académico. Esta dissertação fornece uma ferramenta alinhada com as contribuições científicas em relação ao conceito de sucesso no ensino superior, bem como a implementação de um sistema capaz de gerar automaticamente consultas SQL com base em restrições de alto nível. Inclui o uso dos dados dos alunos contidos no sistema Fénix da Universidade ISCTE-IUL numa aplicação web, de forma a auxiliar análises e investigações. Ao disponibilizar dados relevantes para consulta, pode fornecer uma explicação diferenciada dos caminhos de sucesso no ensino superior, bem como identificar problemas e falhas, para apoiar medidas de intervenção mais eficazes posteriormente.

Palavras-chave – Ensino superior, sucesso académico, sistemas de informação, apresentação de dados, aplicação web.

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List of Acronyms

CSS – Cascading Style Sheets

DBMS – Database Management System

DGEEC – Direção-Geral de Estatísticas da Educação e Ciência

DGES – Direção-Geral do Ensino Superior

FCT – Fundação para a Ciência e a Tecnologia

GPA – Grade Point Average

ID – Identification/identity/identifier

IT – Information Technology

JS – JavaScript

PHP – Hypertext Preprocessor

RDBMS – Relational Database Management System

SAS – Serviços de Ação Social

SQL – Structured Query Language

UI – User Interface

UML – Unified Modeling Language

Chapter 1 – Introduction

1.1. Motivation

Studies concerned in finding hypotheses to produce contexts that favor student success represents increasingly important subject, especially for countries committed in improving the efficiency of their own higher education institutions (York et al., 2015; Kuh et al., 2006; Kolster & Kaiser, 2015).

In order to deal with the pressures of answerability in higher education, particularly in the areas of improving student learning outcomes, information technology (IT) could be a key tool to help researchers finding ways to establishing and enrich strategies and policies that promote success at institutional' bodies through academic data analyzes (Campbell et al., 2007).

Normally, much of the practical studies are usually based on data analysis. Plentiful amount of the information is provided by statistical databases and through surveys.

Although there are international and national statistical platforms that provides data for study, currently there is no exclusive platform for ISCTE-IUL that allows a user to analyze internal academic registries.

The existing academic data from Fénix contains highly relevant student information that can be used as study tools to reveal patterns that lead to academic success/failure.

As there is a core of ISCTE-IUL researchers concerned with reducing school failure and dropout in education, correspondingly, there is also a countless purpose for creating a platform for academic data consultation for better internal study performance.

1.2. Context

According to a study about Portuguese reality (Martins, et al. 2017), the participation of students in Portugal's higher education has been increasing progressively and therefore, the graduate opportunities have multiplied. One of the most widely research issue on higher education relates to expose paths that lead to academic success (York et al., 2015). Currently, "society requires more and better educated people (to be delivered by higher education systems) as the basic driving force for the further sustainable development of the knowledge society" (Kolster & Kaiser, 2015: p.4). Improving student success is a subject that remains a concern of governments, education policymakers, institutional leaders (rectors and principals), practitioners and researchers (Kahu & Nelson, 2018). The vast amount of studies is connected to the global valuation movement and increasing pressures for institutions to evidence student learning and development (York et al., 2015). The concern is common: "Drop-out rates have to be reduced, time to degree has to be shortened and the quality of the graduates should be maintained, or even improved" (Kolster & Kaiser, 2015: p.4).

Briefly and deduced from some documents (Kuh et al., 2006; York et al., 2015), part of this sort of studies normally consists of: reading relevant bibliographical research and synthesizing content; defining which results and which indicators, duly framed, allow to measure success; Identifying a general concept of academic success or state a position on the term and then design conceptual models/frameworks, in order to establish a wide standpoint.

According to what is approach at some studies, to assay a theoretical perspective, it is necessary to require data that correspond to academic success indicators, to measure them and later, and if possible, to reach conclusions (eg. Martins, et al. 2017). Typically, much of the data are usually provided by statistical databases and through surveys. There are multiple platforms that deliver information related to education whose mission is to ensure statistical production and analysis, both nationally as well as internationally. However, there is no system that allows an easy consultation of data at the internal level of the ISCTE-IUL University.

It is well known that information systems have now become an essential part of the education sector in several universities (Campbell et al., 2007; Delavari, 2008). This factor leads to a rise in the capability to assemble, offer, and represent a massive quantity of data about the whole constitution of the institutional body and its interactions with educational systems. So, the responsibility to manage, maintain, integrate large volumes of data has significantly increased for academic institutions (Lotsari et al., 2014; Daud et al., 2017).

The Fénix service typifies a good example of how more and more web technologies represents an integral part of education field and how they have a large positive impact of use. This system grants, through ISCTE-IUL certified users (students, teachers, staff and candidates) a variety of services and features that are present in the daily life of all those who study or work in this institution (Fénix ISCTE-IUL, n.d.). As such, it has the registration of all students who enrolled the ISCTE-IUL university. Which at the eyes of a researcher translates into an invaluable asset of highly relevant student information that can be used as study tools to reveal patterns (Lotsari et al., 2014).

The existence of an academic research domain in ISCTE-IUL that is fairly interested in carrying out studies that reveal responsible factors for student success and failure, validates and justifies the creation of an internal platform that provides academic information. By reusing the content implanted in Fénix database it is possible to establish the provision of an interface that contains information which allows different visions and points of interest in the way of sorting the data. So, at the first place, it is necessary to understand from the researchers' sights what are the platform requirements.

However, developing a platform whose goal is to create new perspectives for visualizing and analyzing data also means that ethics/privacy issues will raise. Guaranteeing and safeguarding the privacy of all those whose information is collected and exposed is extremely necessary and important (Piety et al., 2014). Therefore, one of the core parts of the conception is to sculpt the data in order to normalize and anonymize them according to the policies in force that establish rules on the processing/treatment of personal data relating to people in EU (GDPR - General Data Protection Regulation, 2016).

1.3. Research Question

The research question of this dissertation is:

- Is it possible to develop a platform that provides data stored in Fénix system and supports different definitions of academic success?

1.4. Objetive

The approach involves the following main objective:

- Providing an easy-to-use and flexible platform that without imposing a single definition of success provides the data that supports most definitions.

1.5. Research Method

The research method used in this project is based in the design science research methodology process model (Peffers et al., 2007), and is structured as follows:

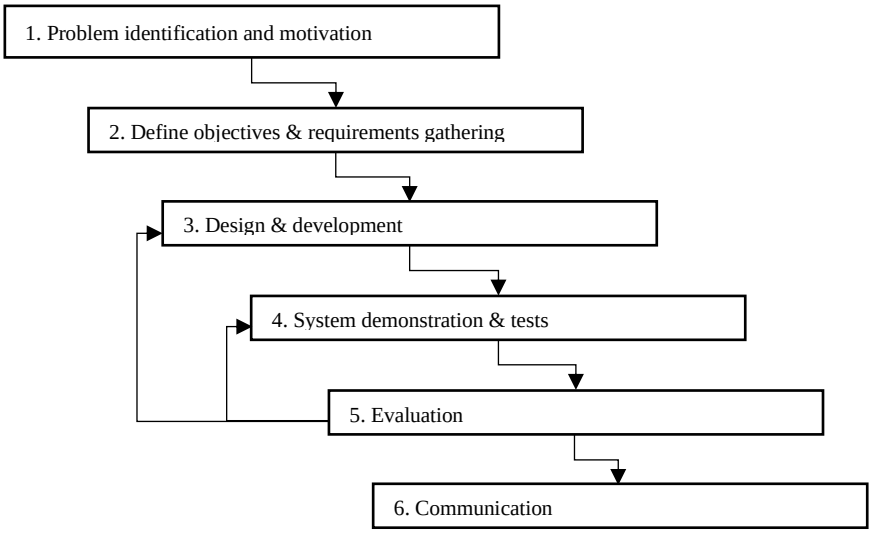


Figure 1.1- Research method

1. The first procedure seeks to identify the research problem and to establish a motivation for the design of the product.

2. The second step refers to deducing the objectives of the product in response to the problem, and also gather requirements for product design.

3. In the third process, all desired features will be determined, including the system architecture, and the elements that will constitute the final product will be developed and implemented.

4. In the fourth step, a set of tests will be performed in order to simulate the usability of the product in several scenarios of the problem.

5. The fifth process is the phase where is made a product comparison with all initial requirements. In turn, it is the phase in which the product will be evaluated according to the objectives previously stipulated and will be measured its usability

and effectiveness in resolving the problem. Points 3, 4 and 5 are cyclical and only when all product requirements are met does the process proceed to point 6.

6. In the sixth process, practical work is concluded and will be communicated how the design and implementation was performed, as well as the usability and efficiency of the product in response to the problem.

Chapter 2 – State of art

2.1. Theoretical Perspectives, Definitions, Indicators

This chapter aims to introduce and synthesize some concepts, indicators and measures, as well as some central theoretical perspectives about academic success, based on literature review.

2.1.1. What is academic success?

"What is academic success?" A complex question that many researchers try to answer. However, even "researchers hesitate to define what constitutes student success. The term has been applied with increasing frequency as a catchall phrase encompassing numerous student outcomes" (York et al., 2015: p.1). According to the same study, York et al. (2015), also mentioned that "ambiguity associated with the definition of academic success is partially attributed to its inherently perspectival nature. Varying constituents view success, and thereby academic success, differently" (p.1).

So, is it possible to come up with a single and generic definition of academic success? It is considered as an abstract term, there are multiple views and interpretations about what success is. That's why some authors attribute the definition of success, in many ways, as subjective. For some people only the above-average results can be considered as success while perhaps for others a bare pass should be sufficient (Nyström et al., 2018).

However, although there is no consensus, it is a field of study that remains in development, and the proof is that the definitions and models related to the term academic success continue to emerge (York et al., 2015).

Perrenoud (2013) affirmed that the idea of school success is currently understood in two senses, in which the first one in a very general way is associated to the performance of students: those who meet the norms of school excellence and progress in the course succeed. Secondly, that school success ends up designating the success of an establishment or a school system. Therefore, Perrenoud (2013) identifies that there is a relationship between these two levels of success. And as far as this view is concerned, R. Levitz and L. Noel (1998) have argued that universities have acknowledged that the success of a student and the success of an institution are attached.

But not all perspectives suggest the same definitions. Kuh et al. (2006: p.5-6), cited that student success can "be defined using traditional measures of academic achievement, such as scores on standardized college entry exams, college grades, and credit hours earned in consecutive terms, which represent progress toward the degree", and "is also linked with a plethora of desired student and personal development outcomes that confer benefits on individuals and society.

However, one of the most used conceptions is based on the principle that the decisive indicator of student success is the achievement of the degree (Kuh et al., 2006; Tinto & Pusser, 2006).

Kuh et al. (2006) aimed to summarize relevant literature and submit a general definition of student success. The report appropriately recognizes that students arrive at their university experiences with a background of prior characteristics and at the same time there are experiences, pedagogies, and contexts that may have measurable effects on student's academic success. Within the scope of the report's objective the authors synthesize the definition of student success as: "academic achievement, engagement in

educationally purposeful activities, satisfaction, acquisition of desired knowledge, skills and competencies, persistence, attainment of educational objectives, and post-college performance" (Kuh et al., 2006: p.7). York et al., (2015) based on the literature review, found the student success and academic success concepts used interchangeably. York et al. (2015) stated that the term academic success works as a vague concept that incorporates a wide-ranging educational outcome and then suggested a model of academic success and a "theoretically grounded definition of academic success that is made up of six components: academic achievement, satisfaction, acquisition of skills and competencies, persistence, attainment of learning objectives, and career success" (p.9).

In the absence of agreement, the wide use of the term ends up limiting intervention actions by educational systems, which are intended to increase institutional effectiveness. Since researchers and administrators do not have the capacity to clearly examine academic success, they are unable to provide any kind of resources and actions (York et al., 2015). Tinto & Pusser (2006: p.8), about this cloudy and wide term, have stated that: "our discussion leaves open, for the moment, the definition of success other than to imply that without learning there is no success and, at a minimum, success implies successful learning in the classroom".

Improving the efficiency of higher education institutions and consequently improving student success remains a concern of education policymakers and all those involved in the education system (York et al., 2015; Kuh et al., 2006; Kolster & Kaiser, 2015; Kahu & Nelson, 2018). The large number of attempts related to the search for models that lead to the success of the student is in turn linked to the pressures for institutions to evidence better students' learning. However, based on literary review it is possible to verify that many of the studies carried out are not generalizable to a single definition of success because the only relate to a part of a rather vast construct (York et al., 2015).

The study must be carried out and the needs must be fulfilled. That's why over the time, deduced from some reports, many authors have been presenting or stating the definition of success based of relevant indicators to measure it. Which in general translates into associate indicators and represent them in the shape of a conceptual model framed in a theoretical perspective (Tinto, 1975; Kuh et al., 2006; York et al., 2015).

2.1.2. Indicators

There is an extensive literature problematic about indicators, which lies in defining the term itself. It is easy to find several definitions but not a consensus among interpretations (Johnstone, 1976).

2.1.2.1. Educational Indicators

From the meaning of indicator, it is possible to suggest at least, that the indicators are information corresponding to measurement scales that identifies quantifiable relations or state, of the characteristic that it is intended to study (Johnstone, 1981).
In turn, further deepening the meaning, an educational indicator points to the extension of some identified aspects of education. In other words, educational indicators can be defined as features which the goal resides in pointing to general aspects of an educational system (Johnstone, 1981).

The concept of indicator framed in the educational field outcomes in the definition of an educational indicator as a statistic that discloses the accomplishment performance

or welfare of the educational system (Oakes, 1986). For a statistic to be an indicator, it must have a standard against which it can be judged. Indicators must meet certain substantive and technical standards that define the kind of information they should provide and the features they should measure" (Oakes, 1986: p.7).
In a way, higher education institutions are also responsible for inspiring a sustainable evolution of knowledge to societies, whose impact mirrors on country's development (Kolster & Kaiser, 2015). Therefore, educational indicators play a very important role in the analysis of the educational sector bodies and, for the purpose of identifying systems' weaknesses, to allow better implementation efforts. Synthesizing, studies evince the importance of performance indicator as the base of quality improvement tool for educational domain (Johnstone, 1976; Oakes, 1986; Selden, 1994; Ogawa & Collom, 1998).

The educational indicator term in the scope of academic success, such as the indicator definition, is an element that reveal the performance of the appropriated aspects to the study of academic success. Gradually have emerged additional aspects of student success, which represents new dimensions and changes on ordinary success indicators (Kuh et al., 2006). As previously mentioned, according to what Kuh et al., (2006) and Tinto & Pusser, (2006) cited, various consider the accomplishment of the degree as the decisive indicator of student success. However, there are more settled success indicators based up on authors opinion's, a few examples are: academic achievement (e.g. Grades/GPA), persistence (e.g. Retention and completion rate), pre-college experiences (e.g. Gender, race and ethnicity), post college performance (e.g. Employment rates), satisfaction, etc. (Kuh et al., 2006, York et al. 2015).

Normally, when evaluating the body of higher education institutions, an indicator does not come as isolated measure, but rather in systems of indicators that represent a relationship between different aspects. Simply put, indicators are settled for each element and the indicator system permits to establish relations between distinct elements (Oakes, 1986). The assortment of indicators represents the indicator system (Ogawa & Collom, 1998). Summarizing, "as a whole, indicator systems can be considered as a representation of educational systems which enables data presentation, the monitoring of key components, and recommendations for policy modifications" (Ogawa & Collom, 1998: p.9).

2.1.2.2. Models and Frameworks as guides for indicators systems

Based upon literature review, quite often, indicator systems are grounded on a conceptual models or frameworks, in order to realize which indicators are relevant to the study (Oakes, 1986; Ogawa & Collom, 1998).

Assuming that education systems are clear and measurable, a model allows researchers to identify which major components to measure in education, as well as to include theoretical relationships among the elements. Generally, the approach of the model is denser, complex, and aims to expose/highlight areas that require intervention or provide evidences into the targeted study's range (Ogawa & Collom, 1998).

The models are widely used and consistent, however, many researchers suggest, alternatively, to construct indicator systems through frameworks. Which are represented as simple structures to form educational areas of interest (Ogawa & Collom, 1998).

While implementing a framework, similarly to the models, it is still able to establish the key elements of interest. The difference lies on the simplicity of the structures, because frameworks do not typically infer relations between the distinct elements and

also are not as likely to request contributory use of the outcomes (Ogawa & Collom, 1998). “Since frameworks are not attempts to build a comprehensive map of the educational system, the data derived from them are more likely to inform discussion rather than prescribe a remedy” (Ogawa & Collom, 1998).

2.1.3. Review of Developed conceptual models

As has been previously mentioned, throughout the times, associated with the attempts to promote better conditions that leads to academic success, several researchers have carried out reports approaching measures, and conceived theoretical perspectives (Kuh et al. 2006; Tinto & Pusser, 2006; York et al. 2015; Kahu & Nelson, 2018).

A conception will be exposed in the follow-up of the report, not as the main one, but instead, as a good approach that not only constitutes a well-founded example of a theoretical frame that highlights the significant elements to measure success according to the author’s view but is also easily moldable to real scenarios.

2.1.3.1. York, Travis et al. (2015)

Going to the heart of the matter, Travis York, Charles Gibson, and Susan Rankin (2015), suggest an overall broad definition of the term academic success. The authors carried out extensive bibliographic research, to realize the usage of the term in higher education. The definitions, considered by the authors as the main ones, were conceptually judged using Alexander Astin's model Inputs-Environment-Outcomes (1991), which ultimately lead to the submission of a revised wide-range meaning and a new conceptual model of academic success.

York et al. (2015) considered I-E-O as the theoretical basis of this study, since it allows the identification of academic success as an outcome and establishes the definition of academic success composed by aspects entitled as inputs or environment.

Therefore, an initial structure emerges (figure 2.1), based on Astin's I-E-O model and literature review prior to this research, which represents, in part, the changes that occurred during the proposal of the term.

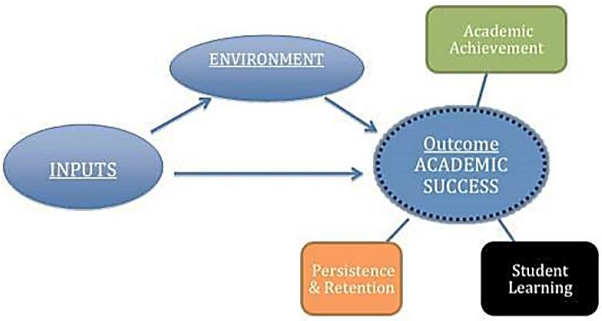


Figure 2.1- Initial framework, York et al. (2015)

This initial framework of academic success is comprised of persistence and retention, attainment of skills/knowledge/competencies and academic achievement. Persistence and Retention are contained as a measure of students’ academic progress, where persistence states to degree completion, and retention refers to the capacity of an

institution to retain students over through their academic course. The student learning is counted in to represent related to program learning outcomes, including cognitive, socialization and affective skills. And finally, the academic achievements as indicators that measure the quality of students' academic work, like grades or grade point average.

Nevertheless, in the opinion of the authors the structure is basic, vague, as it does not meet all the conditions to define academic success. So, the next step, as previously mentioned, goes by adding the literature review to substantiate the perspective.

After completing the review process, the report by Kuh et al. (2006) presented a more wide-ranging definition of academic success, and consequently, became one of the authors' study focus, to analyze this interpretation in relation to others previously revised.

In the analysis, the authors establish theoretical critiques in the report by Kuh et al. (2006), and subsequently promote a solid definition that easily fits into an academic success model (figure 2.2), not only demonstrative in the literature, but also suitable for educational research.

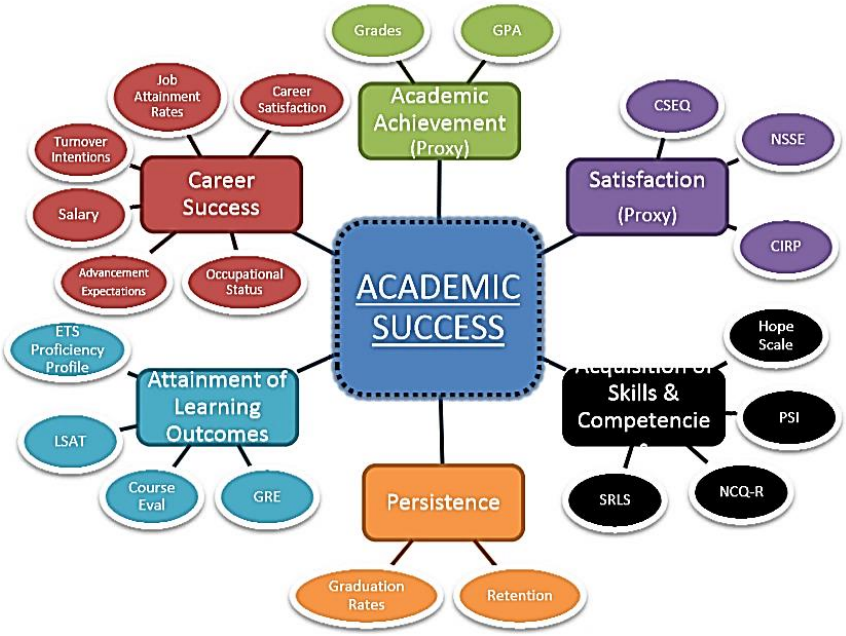


Figure 2.2- Final framework, York et al. (2015)

According to the authors' interpretation, the definition of academic success lies in the set of academic achievement, satisfaction, acquisition of skills and competencies, persistence, attainment of learning outcomes, and post-university performance (more specifically, career success). In the figure 2.2, it is possible to perceive the whole models' structure, the different branches and corresponding measurement elements.

York et al. (2015), included academic achievements as an indicator of students' academic performance, and distinguished this parameter from attainment of learning and acquisition of skills and competencies. Although the authors have assumed that both are related, in the sense that academic performance should be a direct result of learning and acquiring skills and abilities, academic achievement does not inevitably capture students' learning. Therefore, it makes sense to have three distinct branches, in which each presents the respective measurements. The measures presented by the authors to academic achievement are the grades or GPA.

In the following, York et al. (2015) notice that there are also quite considerable resemblances between attainment of learning outcomes and acquisition of skills and competencies, making it difficult to distinguish contextually between these two branches in this model. The authors argue that both can be measured over the course and institutional level, and normally, course tasks and assessments are the primary incomes of measuring these elements at the course level.

Although according to the authors, the literature reviewed on the theoretical distinction between these two indicators is scarce, York et al. (2015) consider that it is still better to split them. Regarding to attainment learning outcomes, embedded elements tend to represent cognitive skills and knowledge. And, in the case of the acquisition of skills and competencies, the incorporated measures are directed on capturing the affective development.

Another indicator presented in this model is satisfaction, although the authors argue that it is not a component of academic success, it is an indicator that captures perceptions of institutional adequacy, acclimatization to the learning environment or achievement of students' goals. In other words, it refers to important aspects of the student's condition within the institutional context, which in turn affect his ability to succeed academically.

Thus, satisfaction offers a measure for contextual aspects, which fit as necessary for the learning environment, as well as, requirements for academic success. According to the literature the authors disclose satisfaction measurements through nationally available institutional surveys or course evaluation (e.g. Course experience questionnaire).

Persistence is another suggested indicator because it aims to represent the ongoing progression of students in an academic degree and can capture students' individual academic goals in various study programs and in various institutional contexts. In summary, it is included in this model of academic success by York et al. (2015), to capture the motivation, focus and progression needed to enable students to complete a study plan. Therefore, the measurements used for persistence are retention between years of university, and degree attainment rates.

Finally, the last indicator is related to post-university performance and is called career success. As the name suggests, it aims to provide information on student performance after attending higher education. The authors, based on other documents, argue that this is divided into two forms of measurement: extrinsic and intrinsic. In which first, respectively, concerns aspects such as job acquisition rates, salaries. While the second, provides measures of career satisfaction, and achievement of professional goals.

In conclusion, despite knowing that the definition of the term academic success is inevitably broad and quite complex, the authors have succeeded in forming a theoretically substantiated definition of academic success. As previously mentioned, after the contextualization of all terms and respective measurement elements introduced in this model suggested by York et al. (2015), it is clear that this model is demonstrative in the literature, as well as, suitable for educational research.

2.2. Using Data to Improve Academic Success Studies

There were times in education, where data did not usually have a position in relation to analysis and decision-making (Earl, 2005). Not only the data related to educational institutions were few, but the ones that existed were difficult to manage, change, and to enable meaningful cohorts between datasets (Matters, 2006).

Currently, due to the technological advances related to collect, share, and represent vast amounts of information that have been taking place, there has been a vast increase of information. Thus, the extensive use of data to settle improvement plan policies and for decision making, is conceivable (Earl, 2005; Matters, 2006).
According to Earl (2005), "data provide tools for the investigation necessary to plan appropriate and focused improvement strategies. Synthesizing and organizing data in different ways stimulates reflection and conjecture about the nature of the problem under consideration. Over time, this process gives rise to defensible plans for changes" (p:7). Directing the focus to the Education sector, a wide diversity of data can be captured linked to the learning context (Matters, 2006).

2.2.1. Academic Information systems

Presently, information systems represent a crucial part of the education area in quite a lot of universities. In the sense that academic systems have produced an extensive data collection that correspond to almost the entire of institution's information (Campbell et al., 2007; Delavari et al., 2008; Voorhees & Cooper, 2014).

The massive increase of data that pertains to the whole composition of the institutional body and its interactions with the educational systems, promotes accordingly, a significantly increase of the responsibility to manage and integrate huge volumes of data for academic institutions (Lotsari et al., 2014; Daud et al., 2017).
It also happens that in the scope of investigation this abundance of data translates into a priceless asset of highly relevant student information, that can be used as study tools to reveal patterns (Lotsari et al., 2014).

According to Earl (2005), although having data is a great start, this is not enough. Under these circumstances, higher education institutions need to go beyond "data-rich to being information-rich and knowledge-rich as well" (p.8). The process of knowledge formation results from the organization and contextualization of information. In turn, relating and giving meaning to information generates knowledge to act properly (Earl, 2005).

However, initially, it is essential to recognize that for universities it is not a common practice to use own data in such ways. Neither all applicable data are collected by institutions, and the existing ones are often not collected for specific study purposes (González, 2009). Therefore, "in the colleges' efforts to increase student success, it became clear that it was necessary for everyone to understand the types of data needed and exactly how such data was to be used" (González, 2009: p.2).

According to Lorna Earl (2005: p.9), "The challenges come in deciding what data are appropriate and useful for their purposes, ensuring the quality of the data and doing the kinds of analyzes and interpretations that will help them make sense of the data". Implicitly associated with the value that the data can possess, lies a judgment in the selection of data according to its quality, the organization of the information, as well as, reflection on the results and application of measures with knowledge (Earl, 2005).

In order to establish where to find data, it is important to match planning goals to indicators categories and, subsequently, from indicators sorts to potential data sources (Earl, 2005).

Lorna Earl (2005), listed nine indicators categories (table 2.1), through a conference with PowerPoint slides, which might be used as a path to data sources.

Indicators Categories
Student/community Demographics
Physical Plant
Student Achievement
School and Teacher Demographics
School Culture
Teaching and Assessment Practices
Programs
Student attitudes
Parent Involvement and Support

Table 2.1- Indicators categories, Lorna Earl (2005)

Gabrielle Matters (2006), based on Earl's (2005) classification, proposed a table (table 2.2) where is jointed links between sources of data and locations of datasets (according to the input-process-output model in the student-learning environment). Which in turn, in the author's perspective, after having established a purpose of study, it's an asset to help in the decision of which data to collect.

Data source	Potential source of data	Data point
Student demographics	Attendance	Input
	Enrollment	Input
	Grade level	Input
	Ethnicity	Input
	Sex	Input
	Firs language	Input
	Health Issues	Input
	Socioeconomic status	Input
Student achievement	Standardized, norm-referenced, criterion-referenced tests	Output
	Questioning in class	Output
	Performance and standards-based assessments	Output
	Teacher-made tests, projects, quizzes	Output
	Teachers' observations	Output
	Grades and grade-point-averages	Output
	Student work	Output
Teaching and assessment practices	Instructional and learning strategies	Student-learning process
	Instructional time and environment	Student-learning process
	Organization of instructional components	Student-learning process
	Assessment practices	Student-learning process
	Classroom management philosophies	Student-learning process
	Item banks	Student-learning process
Parent opinions and behaviors	Parent perceptions	Output
	Parent involvement in the school	Student-learning process
	Parent support of student learning	Student-learning process
School culture	Relationship between educators	Student-learning process
	Relationship between students and educators	Student-learning process
	Beliefs about learning and teaching	Student-learning process
	Professional development	Student-learning process
Staff demographics	Background	Input
	Interests	Input
	Qualifications	Input
	Sex	Input
	Ethnicity	Input
Programs	Program descriptions	Student-learning process
	Course outlines	Student-learning process
	Special programs	Student-learning process

Resources and materials	Computers	Input
	Textbooks	Input
	Software	Input
	Workbooks	Input
	Art supplies	Input
	Musical Instruments	Input
Physical plant	Configuration of space	Input
	Playground	Input

Table 2.2- Sources of data and locations of datasets, Gabrielle Matters (2006)

With regard to higher education, when establishing a purpose in the context of academic success, what data have been relevant to be collected?

2.2.1. Variables used in academic success case studies

Using some documents as reference, performed by Qasem A. Al-Radaideh et al. (2006), Martins et al. (2017), Edin Osmanbegović & Mirza Suljić (2012), T. York et al. (2015), and Aboma Olani (2009), in which the analysis of certain variables was achieved to measure or predict academic success, it was conceivable to establish a synthesized list.

Even though that there are more variables contained in other studies, and suitable to other authors' prospects, this table does not have the function of representing all the variables that can be applied, as well as, does not aim to make a direct comparison, due to the different insights in the origin of the variables. But instead, for exposing, according to several studies, which of the variables have been used, to measure or predict academic success.

Dimensions / Authors	Qasem A. Al-Radaideh et al. (2006)	Martins et al. (2017)	Edin Osmanbegović & Mirza Suljić (2012)	T. York et al. (2015)	Aboma Olani (2009)
Socio-demographic characterization	Sex	Sex	Sex		Sex
	Age	Age	Family (Number of household members)		
	Place of Residency (Family, Friends, Alone)		Distance (From residence to college)		
Social origins		Socio-Occupational Categories (socials classes)			
		Parents Years of schooling			
Previous education	High School Major (Science, Arts, Math's., …)	Earlier failure (year repeated)	High School Major		
	High School Grade	Route of access to higher education	Entrance exam		University Entrance Scores
		Sector in secondary education (Public, Private)			Preparatory Grade Point Average (PGPA)
Characterization of Educational Institutions in HE	Student Department	Sector of educational institution (Public, Private)			Aptitude Test Scores
	Study Type	Education subsystem (University, Polytechnic)			
		Field of Study			
Financial Support	Funding (Private, Scholarship, Local)		Scholarships		
Academic Achievement			Grade Point Average (GPA)	Grade Point Average (GPA)	Grade Point Average (GPA)
	Grades			Grades	
Academic Satisfaction				Overall College Experience	

				Course Experience	
Achievement Motivation			Grade Importance (Quantified Importance)		Motivation
Academic Self-Efficacy					Efficacy
Persistence	Repeat (Number of repeats)			Degree Completion Rate	
				Retention	
Acquisition of Skills and Competencies				Critical Thinking	
				Academic Skills	
				Affective Outcomes	
Attainment Learning Objectives				Engagement	
				Institutional Objectives	
Commitment		Average number of hours per week in class activities	Time spent studying		
		Average number of hours per week studying			
		Average number of hours per week working			
Resources and materials			Materials of Study		
			The Internet (Yes, No)		
Post-College Career Performance			Earnings	Extrinsic (job attainment rates, promotion histories)	
				Intrinsic (career satisfaction, professional goal attainment)	

Table 2.3- Variables used in some practical studies of academic success

But, subsequently the selection and collection of the potential data sources, how to transform the data into knowledge? In other words, how to use the data?

2.2.2. The Impact of IT's Application on Academic Success

Many authors share the idea that IT is seen as a key element of research because through the data presentation, data analysis or data mining it is possible to face some challenges imposed in higher education. More specifically, in the areas where the goal is to promote enrich educational policies at institutional' bodies and improving student learning outcomes (Luan, 2002; Campbell et al., 2007; Delavari et al., 2008; González, 2009; Voorhees & Cooper, 2014). According to Campbell et al. (2007), "analytics marries large data sets, statistical techniques, and predictive modeling. It could be thought of as the practice of mining institutional data to produce actionable intelligence" (p.44).

Currently, despite the use of data analysis in higher education is centered for higher-level organizational decision, it is expected that the use of analytics raise in areas such as academic success. Since, academic analytics has a remarkable potential to produce actionable knowledge in order to improve learning, teaching and student success (Campbell et al., 2007, Voorhees & Cooper, 2014).

Data settled in specific forms, provides information aimed at the stakeholder's intentions, to support judgements and decisions (Axworthy, 2005).

2.2.3. Existing platforms of data presentation and analysis

There are some agencies that are responsible for the collection, organization, systematization and dissemination of information in an easy and accessible way. Typically, the method by which the data is disseminated is through statistical platforms where the research can be performed mainly intuitively. Throughout the chapter, some of the entities that provide this type of services applied to Education will be presented.

2.2.3.1. DGEEC

An example of a national digital educational statistics platform that provides data in Education area, is the DGEEC – Direção-Geral de Estatisticas da Educação e Ciência, which is a body of the Ministry of Education and Science. In accordance to the information outlined in the mission description, this platform aims to ensure the education and science statistical production and analysis, providing procedural support to policy formulation, as well as, strategic planning and operational (DGEEC).

Through this platform it is possible to access a broad set of educational indicators, faster and interactively. These are structured as in accordance with the following tables.

Higher Education	Vacancies in Higher Education
	New Enrolled Students
	Enrolled Students
	Graduates
	Academic Staff

Table 2.4- Educational indicators included in the DGEEC platform

Pointing specifically to higher education indicators, correspondingly based on the information provided by the DGEEC interface, the following indicators are obtained (table 2.5):

Educational Indicators	
General Education Indicators	Indicators of Right to Education
General Data	Universal Primary Education
Pre-School Education	Accessibility to Secondary and Higher Education
Basic Education	Curricula and Educational Resources
High School	Educational Opportunity and Freedom
Higher Education	

Table 2.5- Higher education indicators included in the DGEEC platform

As it is visible in the images below, this platform allows the navigation, indicators selection, data exploration and export to different formats (Excel and ODS).


DGEEC DIREÇÃO-GERAL DE ESTATÍSTICAS DA EDUCAÇÃO E CIÊNCIA

5. Índice de indicadores relativos ao ensino superior no século XXI

5.1. Vagas para cursos de formação inicial, por natureza do estabelecimento e tipo de ensino, em Portugal (2006/07 a 2017/18)

5.2. Inscritos no 1.º ano pela 1.ª vez, por natureza do estabelecimento e tipo de ensino, em Portugal (2006/07 a 2017/18)

5.3. Inscritos, por nível de formação, em Portugal (2006/07 a 2017/18)

5.4. Inscritos, por natureza do estabelecimento e tipo de ensino, em Portugal (2006/07 a 2017/18)

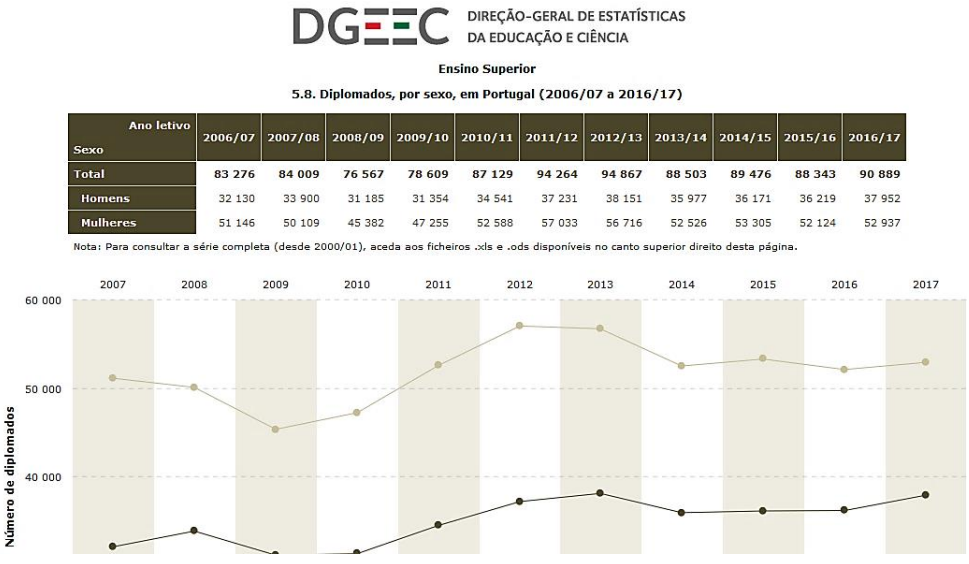
5.5. Inscritos, por sexo, em Portugal (2006/07 a 2017/18)

5.6. Diplomados, por nível de formação (2006/07 a 2016/17)

(...)

Figure 2.3- Index of DGEEC indicators for higher education

As an example of consultation, the selected indicator was "graduates, by sex, in Portugal", and the solution offered corresponds to the following figure.


DGEEC DIREÇÃO-GERAL DE ESTATÍSTICAS DA EDUCAÇÃO E CIÊNCIA

Ensino Superior

5.8. Diplomados, por sexo, em Portugal (2006/07 a 2016/17)

Ano letivo / Sexo	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Total	83 276	84 009	76 567	78 609	87 129	94 264	94 867	88 503	89 476	88 343	90 889
Homens	32 130	33 900	31 185	31 354	34 541	37 231	38 151	35 977	36 171	36 219	37 952
Mulheres	51 146	50 109	45 382	47 255	52 588	57 033	56 716	52 526	53 305	52 124	52 937

Nota: Para consultar a série completa (desde 2000/01), aceda aos ficheiros .xls e .ods disponíveis no canto superior direito desta página.

Figure 2.4- Example of a data query on the DGEEC platform

After the query example, below is an example to represent the ease of exporting data, in this interface.

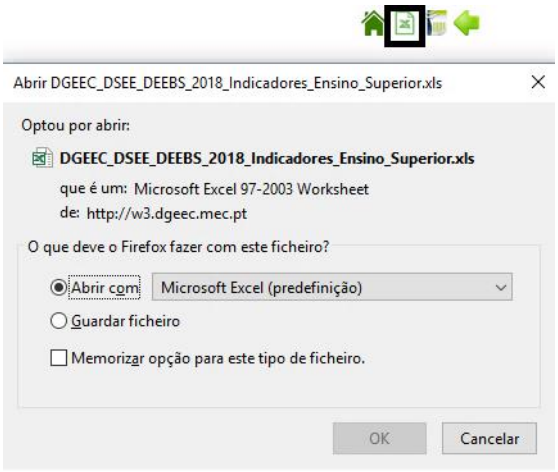


Figure 2.5- Example of exporting data, DGEEC

2.2.3.2. PORDATA

According to what is labelled in the platform description, PORDATA supports the collection, systematization and dissemination of data on multiple areas of society, on Portugal and its municipalities, and on the European countries. The reported statistics derive from official and certified sources, with data production skills in the respective areas (PORDATA). Regarding education in higher education, several aspects that might be consulted as presented in the following image are present on this platform. Although, the image does not refer all, it suggests how the consultation can be done.

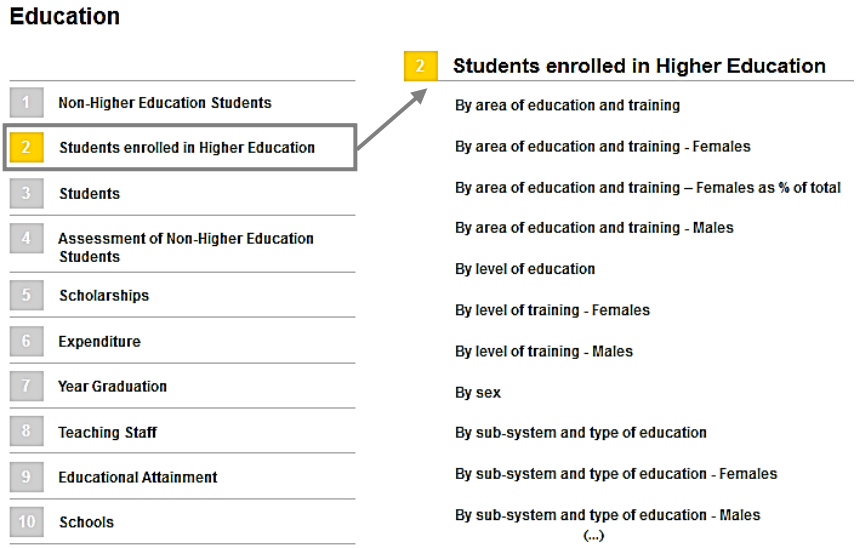


Figure 2.6- Index of PORDATA indicators for education

While choosing some of the indicators, besides the chart and graph in the platform, several functionalities are provided, such as description of the data (metadata), options of graphs, filters in the data and export methods (excel and pdf).

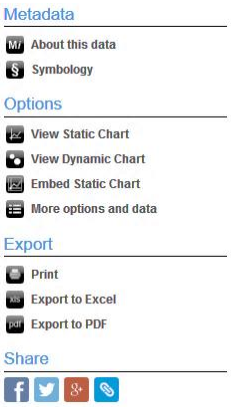


Figure 2.7- Set of options provided by the PORDATA platform

For example, in the case of consultation "Students enrolled in Higher Education: By sex" the following information is provided:

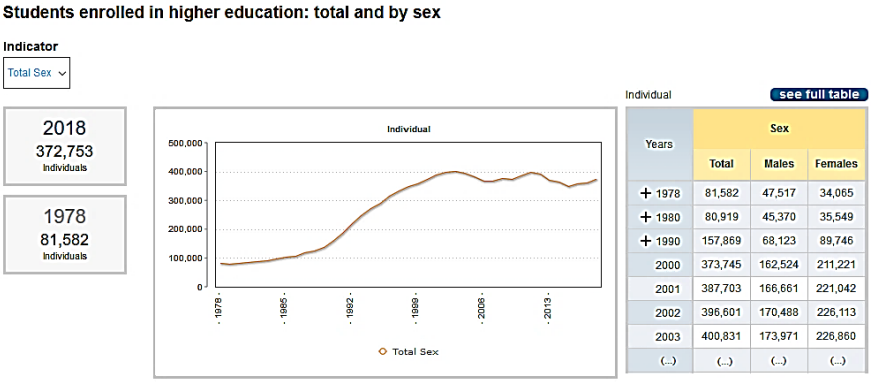


Figure 2.8- Example of a data query on the PORDATA platform

If desired to export this data in Excel format for different views, the procedure and result are as follows:

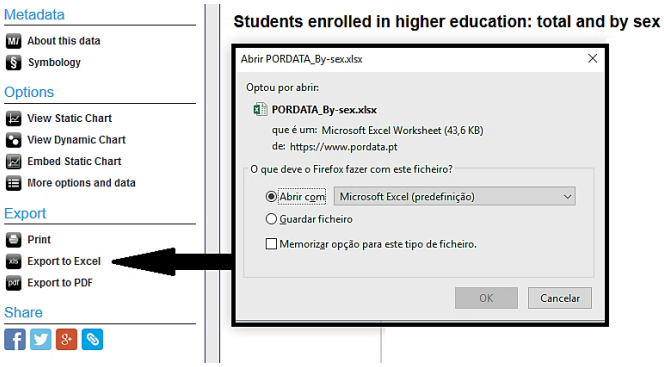


Figure 2.9- Example of exporting data, PORDATA

PORDATA

Students enrolled in higher education: total and by sex

Individual

Years	Sex		
	Total	Males	Females
1978	81 582	47 517	34 065
1979	79 436	45 325	34 111
1980	80 919	45 370	35 549
1981	83 754	46 012	37 742
1982	86 789	46 697	40 092
(...)	(...)	(...)	(...)

Figure 2.10- Excel generated by data export, PORDATA

2.2.3.3. Eurostat

Eurostat is the statistical office of the European Union, whose key role is to provide statistics for Europe so that it is possible to define, implement and analyze improvement policies in various sectors (Eurostat).

The platform allows several alternatives to query data that is contained in the database, and where one of the methods specifically allows to browse statistics by topics. The following table sets out, according to Eurostat, which categories are available.

Indicators Categories								
General and regional statistics	Economy and finance	Population and social conditions	Industry, trade and services	Agriculture and fisheries	International trade	Transport	Environment and energy	Science, technology, digital society
		Education and Training						

Table 2.6- Indicators categories included in the Eurostat platform

As seen through the table 2.6, Eurostat has an extensive collection of indicators from different sectors. Shifting the focus to aspects relevant to education, included in the topic "Population & Social conditions" lies elements related to "Education and Training", as mentioned in the following image, which exposes the database layout.

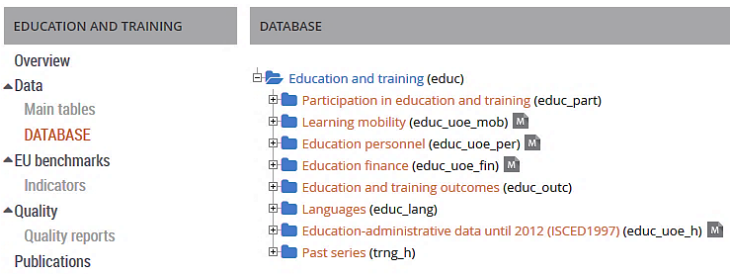


Figure 2.11- Education and Training, Eurostat database

In the case of a search, this platform has a lot of features. All indicators have metadata, with detailed descriptions, each branch enables data exploration, as well as, exportation in many formats (Excel, CSV, HTML, PC-AXIS, SPSS, TSV and PDF).

The following images represent an example query, which results in the exploration and visualization of data, and lastly, the export. This query starts with the navigation in the database tree, where the selected branch is called "Education and training outcomes" and then is selected, within this branch, "Graduates in tertiary education, in science, math. computing, engineering, manufacturing, consultation, by sex - per 1000 of population aged 20-29".

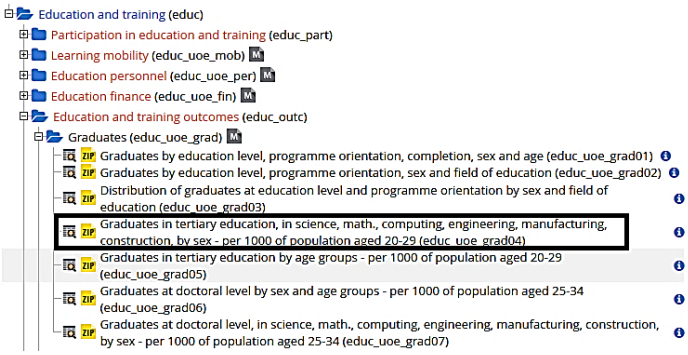


Figure 2.12- Index of Eurostat indicators for education and training

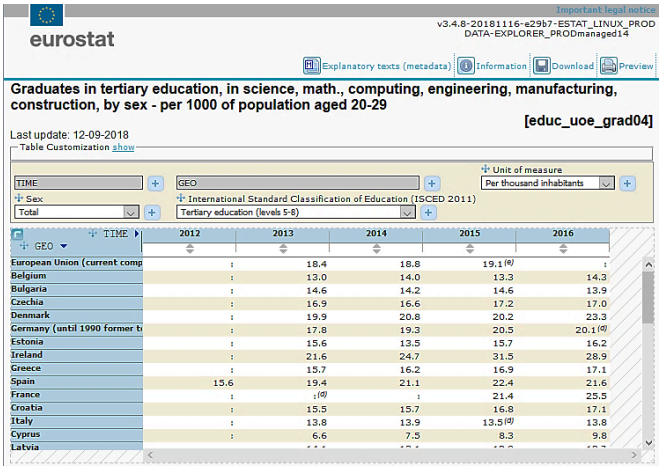


Figure 2.13- Example of a data query on the Eurostat platform

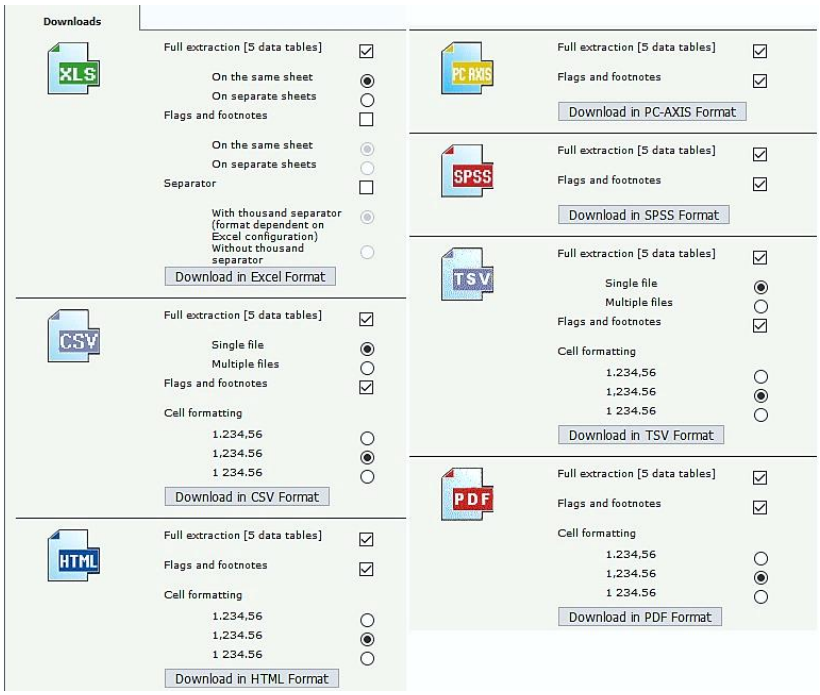


Figure 2.14- Example of exporting data, Eurostat

Chapter 3 – Requirements gathering

The requirements gathering focused on two core issues: what do we need vs. what do we have. For the first question respectively, the attempted answer resulted in a process of several interviews, in order to highlight with different perspectives what would be some of the general notions and definitions of academic success, as well as some of the main points for measuring academic success/failure. For the second question, respectively, the focus was on the correlation between the overall interview outcome and the supply of data from the Fénix system database.

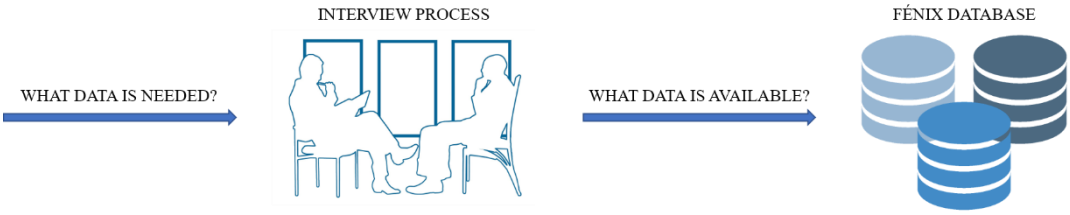


Figure 3.1- Requirements gathering process sequence

3.1. Interview process

The process prior to the creation and design of the platform consisted of a set of interviews with a qualitative purpose in order to collect different perspectives regarding to the academic success topic, as well as to identify the main needs of potential users with regard to the type of data on the which there will be more interest in consulting.

The interviews were guided by a script (Appendix B) composed of five questions:

1. What is your definition of academic success?
2. What factors are most involved or condition academic success?
3. Which segments of students may be more vulnerable to failure?
4. Given the universe of the Fénix system, what are the data that seem to be most relevant to establishing indicators of academic success? Or others that with this concept may be related or implied in its explanation?
5. Comment on the possible usefulness of having a platform that allow to consult and download academic data related to academic success.

To establish a more wide-ranging view, teachers with qualifications in different areas were interviewed. The interviewed set was composed by a total of six ISCTE-IUL teachers. Including the President of the Pedagogical Council, the School of Technology and Architecture director, the director of the Sociology department, the director of Sociology Degree, the director of Computer Engineering Degree, and a psychologist from the student counseling office.

As expected, the difference between areas of training eventually reflected certain discrepancies in the definitions of success. However, academic success measured through student performance throughout the course frequency was recorded in all interviews.

3.1.1 Interviews' outcomes

Some perspectives cover the definition of academic success as obtaining the degree for the stipulated time, depending on the statute of the student (part time, full time, student worker, international student). Others tend to distinguish multiple success levels based on the number of completed courses per year versus the stipulated, at the time the student is approved for the next curricular year. There are perspectives that refer to a definition of success where the set of skills and knowledge (theoretical / practical) acquired throughout the course predominates. Some visions highlight academic success such as the combination of student performance, acquisition of knowledge, continuity of studies or pursuit of a professional career in the technical area of training. Finally, some argue success as the result of a very comprehensive enriching experience in the academic context that includes overcoming a set of academic goals (complete the courses of the respective academic years, acquiring a degree) as well as the acquisition of features regarding to the personal (personal development), social and intellectual skills, and that ultimately allow a student update or form a potential.

In addition to the general definitions of the term success in higher education, a number of factors that may influence academic success have been collected through this process, as well as segments of students that may be vulnerable to failure. The first being respectively:

- Satisfaction of the student with the frequency of the degree;
- Demographics factors;
- Enrollment choices;
- Integration in the university environment (student involvement in the institution, social relations with teachers and students);
- Family background (parents' education and profession);
- Student training framework (previous course);
- Student work methodology (planning and time management, study habits, autonomous and group work capacity);
- Student motivation;
- Aptitude for the training area;
- Institutional factors (evaluation methods, teaching approaches, methods and good pedagogical practices, provision of suitable spaces for study, content repository);
- Course (difficulty and requirement of the course)
- Teachers (ability to transmit knowledge, agility and availability to clarify doubts);
- Socioeconomic factors.

And the seconds being respectively:

- International Students (Portuguese language barrier, different assessment and teaching methods);
- Displaced students;
- Students with a vulnerable socio-family background;
- Students with low schooling family background;
- Students with economic shortages;
- Students with low motivation;
- Students who do not attend classes;
- Students with low previous education preparation;
- Students with difficulties in adapting not only to assessment methods, but also to teaching methods and practices;
- Students with integration difficulties;
- Students who are unsure of the degree choice;

Linking the definition of academic success and the factors related to student's success, supported by the sum of the interviewees' perspectives, with the framework and general definition presented by Kuh et al. (2006), it is possible to find some similarities. As previously mentioned, in the authors' vision (Kuh et al., 2006), student success is defined as "academic achievement, engagement in educationally purposeful activities, satisfaction, acquisition of desired knowledge, skills and competencies, persistence, attainment of educational objectives, and post college performance" (p.7). The guiding framework presented to support the Kuh et al. (2006) study corresponds to the following figure.

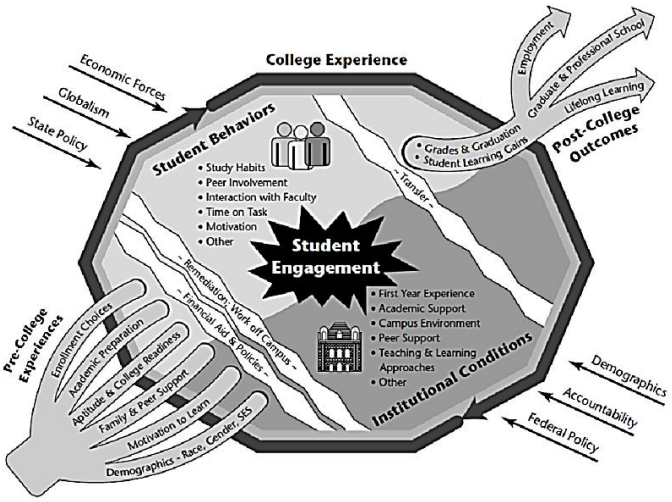


Figure 3.2- What matters to student success (Kuh et al., 2006)

The figure bellow appears in the attempt to create a possible framework, minimally comparable to the scenario presented by Kuh et al. (2006), where the sum of the definitions and factors described by the interviewees, relevant to academic success, were presented.

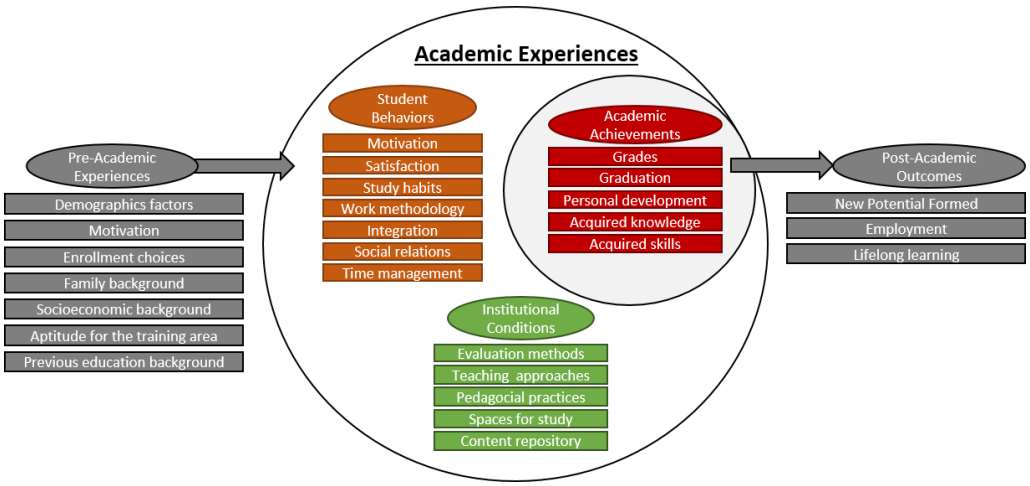


Figure 3.3- What matters to success according to interviewees

In the following of the interview, subsequent to the collection of definitions and factors measured as important to the term academic success, and considering the universe

of the Fénix system, it was asked which data would be most relevant to establish indicators of academic success or which information could be implicated with this concept. The answers were as follows:

- Age;
- Sex;
- Nationality and second nationality;
- Place of residence;
- Parents' education and profession;
- Specifics related to previous education (Public / Private, specificity area);
- Number corresponding to the ingression degree preference;
- Higher education ingression grade;
- Enrollment;
- Registration in courses;
- Grades in courses;
- Degree grade point average;
- Approval rates to courses;
- Attendance;
- Number of courses completed per year;
- Access to higher education (normal, post-work);
- Student statute (Worker student, international student, displaced student, scholarship student);
- Erasmus students;
- Course's content repository.

3.1.2. What data is needed?

By grouping the proposed indicators into blocks of dimensions, it ends up reflecting an easier and structured analysis.

	Dimensions	Indicators	Additional Information
Pre-Academic Experiences	Socio-demographic characterization	Sex	
		Age	
		Place of Residency	
		Nationality and second nationality	
	Family background	Parents' education and profession	
	Previous education	Precedent degree designation and conclusion year	
		Previous education sector	Public, private or both
		Specificity of study' area or field of study	(Ex: Economy, arts, etc.)
		Candidacy preferences	
		Access Type	Normal regime, post-work regime
		Higher education ingression grade	
Academic Experiences	Students' profile	Working student	
		Partial time student	
		Dislocated student	
		International student	
		Scholarship	

		Outgoing mobility	Erasmus students
	Persistence	Enrollments	Number of enrollments per degree
		Retention in courses	Uncompleted courses
		Attendance	Attendance in courses' classes
	Academic Achievement	Course's grades	
		Courses completed per year	
		Degree grade point average	
	Degree's proprieties	Approval rates to courses	
		Course's content repository	
		Degree Completion Rate	

Table 3.1- Indicators proposed through the interviews by dimensions

When it was questioned about the usefulness of the platform, the majority of the interviewees considered quite interesting the idea of having an interface that allows to consult and export institutional data related to academic success. In the sense that the Fénix system contains huge volume of information, and by taking advantage of it to provide an easy access in order to consult institutional data by looking for solutions that are not available through the regular use of Fénix, can enable to establish wide-ranging visions, which subsequently could introduce more effective measures to combat school failure and drop out in higher education.

3.2. Data selection process

3.2.1. What data is available?

After gathering definitions, indicators and potential sources of information correlated with academic success, it is necessary to form the following question so that the following steps can be taken in the development and design of the data consultation platform. What data do Fénix system database has that is related to the proposals exposed during the interviews? In answer to the question follows table 4.2, that shows which variables and data types are in the Fénix system database related to what was asked.

Variables	Additional information
Sex	Variable related to students' gender
Place of Residency	Variable related to students' place of residency
Year of Birth	variable related to students' year of birth
Nationality	Variable related to students' nationality
Second Nationality	Variable related to students' second nationality
Parents' Profession	Variables related to the profession of the students' parents
Parents' Education	Variables related to the education of the students' parents
Marital Status	Variable related to students' marital status
Precedent degree designation	Variable related to the designation of the students' previous degree
Precedent degree conclusion year	Variable related to the conclusion year of the students' previous degree

Previous education sector	Variable related to the type of school attended in high school (Ex: Public, private or both)
High School Completion Course Type	Variable related to the high school course or area, which appears in DGES's candidacies (Ex: Scientific-Humanistic course, equivalence, etc.)
Candidacy preferences' order	Variable related to the candidacy preferences' order
Higher Education Ingression Grade	Variable related to the overall access grade
Access Type to Higher Education	Variable related to the students' type of access to higher education (Ex: General access regime, part-time regime, degree holder, etc.)
Special Education Needs	True, if the student has special needs status.
Displaced Student	True, if on enrollment via DGES the student indicated that he was displaced
Transport Supplement	True, if the student has transport supplement
Accommodation Supplement	True, if the student has accommodation supplement
Scholarship	True, if the student has any sort of scholarship (FCT or SAS)
Iscte Financial Support	True, if the student has Iscte financial support
Student Statue	Variable related to the students' statute in higher education system (Ex: SAS or FCT grant owner, Working student, Partial time student, International Student, etc.)
Outgoing Mobility Period	Indicate if the student at ISCTE-IUL will be attending a semester or a year at a non-Portuguese higher education institution
Degrees' Designation	Variable related to degrees' designation
Degrees' Type	Variable related to degrees' type (Ex: Degree, master's degree, PHD degree, etc.)
Degrees' School	Variable related to degrees' school (Ex: ISTA, ECSH, EG, ESPP, IPPS, etc.)
Registration State	Variable related to the students' registration state (Ex: Registered, concluded, interrupted, quitted, etc.)
Subjects' Designation	Variable related to the subjects' designation
Subjects' ECTS Credits	Variable related to the subjects' ECTS credits
Subjects' Grade Scale	Variable related to the subjects' grades scale (Ex: 0-20, etc.)
Subjects' Grade Value	Variable related to the students' final grades to subjects

Table 3.2- Some of the variables available in Fénix system database

Considering the variables mentioned in the interviews and correlating with some of the variables in the Fénix database (table 3.1, 3.2), it is possible to verify in advance that even though Fénix is not a platform for the purpose of an academic success-focused tool, it collects a lot of information from the students that in the eyes of an interested person, can have a lot of potential in the ambit of academic success.

Chapter 4 – Databases designing

4.1. Main database conception

In order to create a platform for the purpose of making data available for consultation, it is necessary to develop a database in which the system accesses to perform the requested queries. Since initially this platform will import data contained in the Fénix database but will constitute an independent service. This requires designing and structuring a smaller database than the Fénix database containing only the relevant and desired information.

Figure 4.1- Main platform database design process sequence

For a good performance of any information system, it is an essential condition that the information be properly structured. Because, through a good structure, it becomes easier and more intuitive to ensure its maintenance and consultation (Ramos, 2008).

Over the years, various languages have been developed and used to help structure and organize information. Being the relational model one of the most privileged methods, as it is supported by the vast majority of information systems development tools (Ramos, 2008). In addition, the UML (Unified Modeling Language), as an aid to relational model design, has been widely used because it fits within the framework of conceptual modeling languages and consequently allows to manipulate semantically richer concepts than those that describe database models (Ramos, 2008).

Thus, throughout this chapter are presented the UML class diagrams, as well as the relational model diagram, both proposed for the design of this platform database.

4.1.1. UML Class diagram

Of the UML set of diagrams, only the class diagram was used, since to represent the specifications needed to design a database is the best suited. During the design of the class diagram was used the BOUML software, which is a free tool for designing and modeling UML diagrams (classes, use case, sequence, among others).

Class diagrams are intended to represent the systems structural component and allow the design of a relational database using concepts closer to a non-computer professional (Ramos, 2008). Not going much deeper theoretically, for the design of a diagram concepts such as objects, classes and relations are used. Prior to the final drawing of the class diagram, these terms will be contextualized in order to make it reasonably understandable.

4.1.1.1. Objects and Classes

Briefly, an object is considered as something that is distinct, characterized by a set of attributes and relevant to the scope of the information system (Ramos, 2008).

When sketching an information structure, it is not practicable to represent all objects in the system. The notion of class in UML allows you to represent and define objects in aggregate form. Being a class, a description of a set of objects that share the same attributes, represent the same semantic reality, and over which the same operations can be performed (Ramos, 2008).

In the following figure, the graphical representation of a class is presented. In this scenario, the student class appears as an example and, in turn, represents all students (objects).

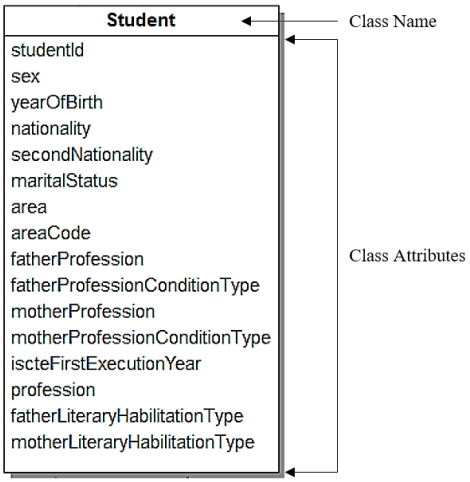


Figure 4.2- Example of a class in the context of this information system

4.1.1.2. Relations between classes

In an information system, objects are not isolated, they relate to other objects, including objects from other classes. UML provides some types of relationships specific to different contexts. Contemplating thus two types of relations: associations and generalizations (Ramos, 2008).

Not all relations in UML will be theoretically contextualized since the purpose is only to explain the logic of all relations contained in the final class diagram model.

Starting with associations, these are one of the main ways to embody the relations between class objects. An association that joins two classes represents all the existing links between the objects of both classes. At each end of the associations, ranges of values are indicated, where each value can diverge from 0 to infinity (symbol, *), in order to represent the cardinality (lower and upper limit) of an association (Ramos, 2008).

Multiplicity	Option	Cardinality
0..1		No instances or one instance
1..1	1	Exactly one instance
0.. *	*	Zero or more instances

Table 4.1- Multiplicity values used on the final class diagram

Below are the figures and explanations corresponding to the sort of associations present in the final diagram. The first, respectively, corresponds to a graphical representation of an association whose classification according to limits is defined by "one to many". It reads as follows: A candidacy can only have one year of execution, and in one year of execution there may be many candidacies.

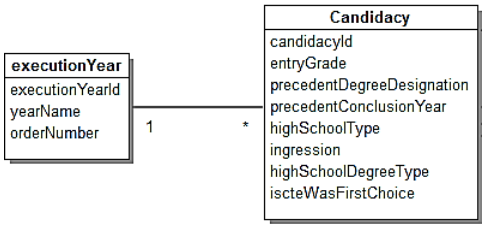


Figure 4.3- Graphical representation of an association: one to many

Subsequently, is presented an association whose classification according to upper bounds is defined by "many to many" and reads as follows: A registration may have many years of execution and, in a year of execution, there may be many registrations. In this example, there is also the association class called "RegistrationByExecutionYear" which consists of an association that assumes some characteristics of the classes, specifically the fact that it might be characterized by attributes but remains an association.

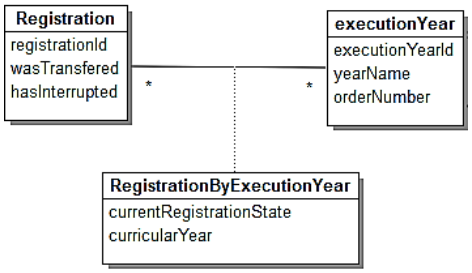


Figure 4.4- Graphical representation of an association: many to many

The following is an illustration corresponding to the graphical representation of an association classified according to the upper limits as "one to one". And it reads as follows: A registration can only relate to one candidacy, and a candidacy cannot give rise to more than one registration.

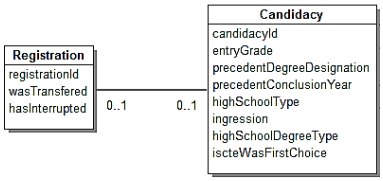


Figure 4.5- Graphical representation of an association: one to one

Then follows an example of a special case which appears at the final class diagram referring to an association, known per composition. This special type of associations is used to highlight a notion of a whole composed of parts. When using a composition, it is assumed that the objects employed for the composition alone are not distinguishable from the rest, and therefore can only be referred in the context of the objects that compose them (Ramos, 2008). In the illustrated example a year of execution is characterized by the composition of its execution periods. By implying that for two different execution years the execution periods may be repeated, hence the execution periods must be distinguished from each other through the execution year of which they are part of.

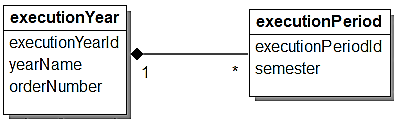


Figure 4.6- Graphical representation of an association: composition

The next illustration represents another kind of relationship between classes, which is the generalization, and consists in a relationship that represents an idea of the object specificity, as well as the partition of a set into subsets. Classes represent sets of objects, however, in these sets of objects there may be subsets that share specific information, not relevant to the other objects (Ramos, 2008). In the diagram shown in the figure, the student class is regarded as the superclass and the special regime student class as the subclass. Assuming that a student may or may not be a special regime student, but a special regime student is a student.

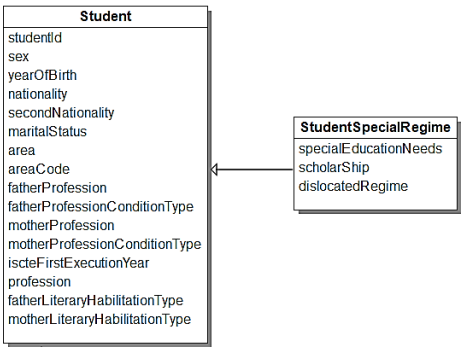


Figure 4.7- Graphical representation of a generalization

All previously exposed relationships make up the final class diagram model. And while these are not all the existing links in the model, they do relate to all the existing types of relations. Allowing in turn, the clarification of other relations with the same type in the model.

4.1.1.3. Final result of Class Diagram

After all the theoretical contextualization of all the kinds of relations (associations and generalizations) present in the class diagram model and based on the information in the Fénix system and how it relates, it was possible to design the following class diagram.

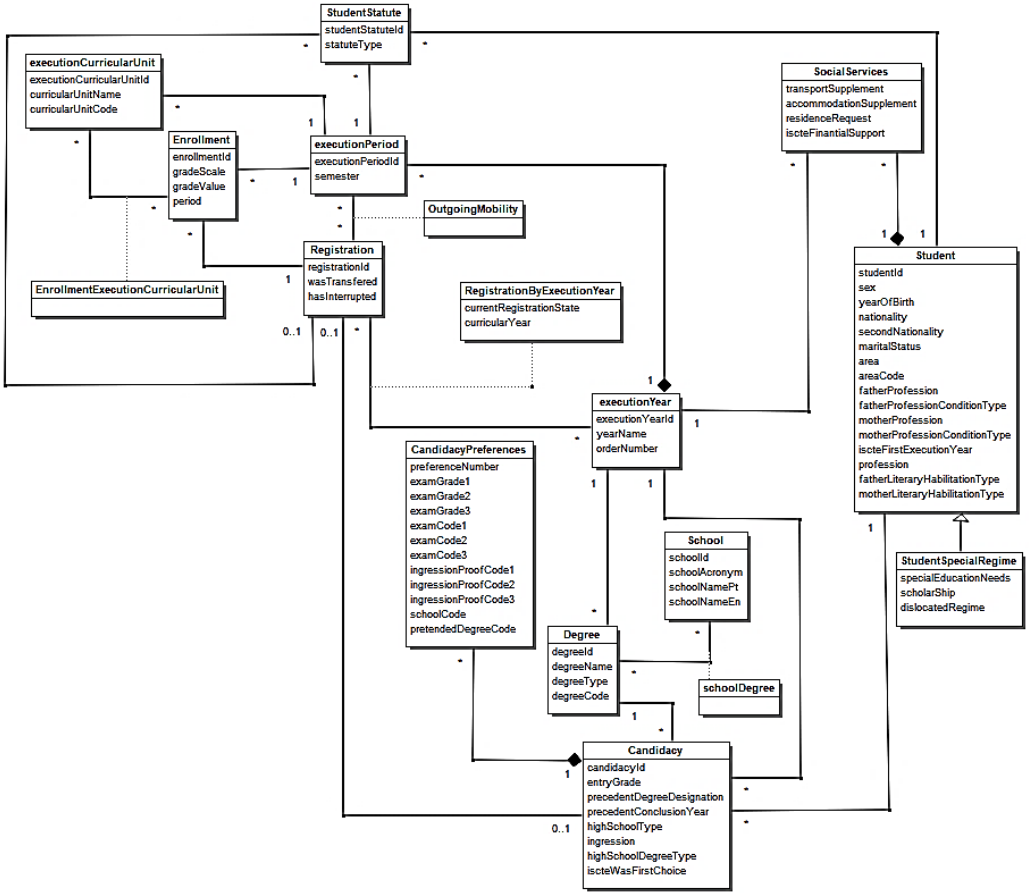


Figure 4.8- Class diagram of the platform's main database

Some of the concepts used in class names and attribute names have been adopted in similarity to the names in the Fénix information system to try to ensure better interaction between systems. Since, in order to continue the purpose of the platform, it will be necessary to import updated Fénix data every school year and maintaining some of the semantics between the two information systems will partly simplify the process.

The following table corresponds to the description of each class present in the class diagram model, in order to contextualize the semantics used in each denomination.

Class	Description
Student	Allows to represent and describe all students.
StudentSpecialRegime	Allows to embody a subgroup of students with special regimes.
StudentStatute	Describes and characterizes all student statutes.
SocialServices	Allows to represent all the conditions of the student's social services.
Candidacy	Represents all higher education candidacies at ISCTE-IUL.
CandidacyPreferences	Allows to represent all candidacy preferences.
Degree	Allows to embody and describe all existing degrees in ISCTE-IUL.
School	Represents all existing schools on ISCTE-IUL.
Registration	Allows to embody and describe all registrations made in ISCTE-IUL.
Enrollment	Represents all the enrollments to the curricular units.

ExecutionCurricularUnit	Describes and represents all curricular units.
ExecutionPeriod	Represents every period of execution in ISCTE-IUL.
ExecutionYear	Allows to represent every year of execution in ISCTE-IUL.

Table 4.2- Descriptions of the classes in the main final diagram

And the table below corresponds to the description of all association classes, allowing the contextualization of the vocabulary used.

Association Class	Description
SchoolDegree	Allows to associate a school with a degree.
RegistrationByExecutionYear	Relates a registration to a year of execution.
OutgoingMobility	Establishes information related to student's outgoing mobility.
EnrollmentExecutionCurricularUnit	Allows to relate an enrollment with a curricular unit.

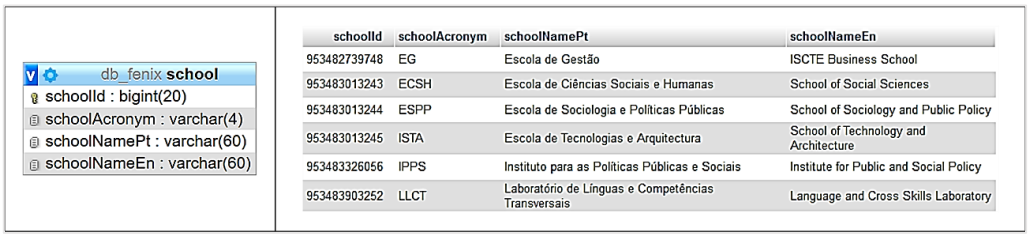
Table 4.3- Descriptions of the association classes in the main final diagram

4.1.2. Relational Model

As mentioned earlier, the relational model is still one of the preferred supports used by systems for storing information. The origin of this preference is essentially due to the simplicity and ease of use embodied in this model. A database consists of information stored in a structured manner. In the relational model information is structured in relationships, also referred to as tables (Ramos, 2008).

4.1.2.1. Table concepts (columns, rows, keys, relations)

A table is made up of a set of columns and rows. Where the columns correspond to the attributes on which values are stored, and the rows are the stored values. Each column is associated with a set of valid values, termed as a domain. Usually domains are defined using valid data types (numbers, characters, etc.).



schoolId	schoolAcronym	schoolNamePt	schoolNameEn
953482739748	EG	Escola de Gestão	ISCTE Business School
953483013243	ECSH	Escola de Ciências Sociais e Humanas	School of Social Sciences
953483013244	ESPP	Escola de Sociologia e Políticas Públicas	School of Sociology and Public Policy
953483013245	ISTA	Escola de Tecnologias e Arquitectura	School of Technology and Architecture
953483326056	IPPS	Instituto para as Políticas Públicas e Sociais	Institute for Public and Social Policy
953483903252	LLCT	Laboratório de Línguas e Competências Transversais	Language and Cross Skills Laboratory

Figure 4.9- Representation in the model and corresponding table

All tables are associated with a fundamental property, which is a unique identifier of each row of the table, called a primary key. This identification function is usually assigned to one of the attributes of the table (becoming a key-attribute). In the example illustrated above, "schoolId" is the primary key of the "School" table. It was chosen this way because it allows to distinguish one school from the others, and in turn there cannot be two schools with the same "schoolId".

Briefly, the relational model aims at an appropriate table-level structure that provides cross-reference of relevant information. However, for the information crossing to occur, it is necessary to develop thoughtful structures, so that tables assume attributes of each other allowing data to be crossed. Following the previous example and taking into account the real context of the application of these theoretical concepts, an illustration emerges that represents a relationship present in the relational model, between the "school" and "degree" tables and presents a structured logic that allows information to be crossed between schools and degrees through the "schoolDegree" table.

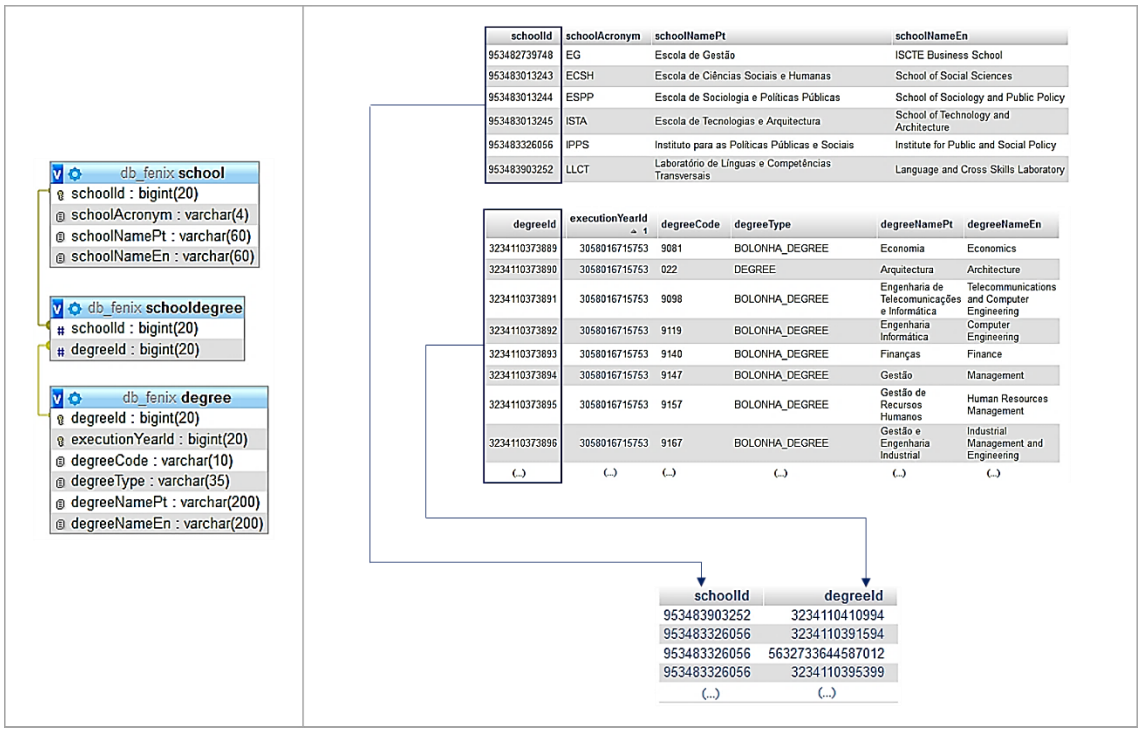


Figure 4.10- Data crossing between tables

This crossing of information presented in the "schoolDegree" table only associates existing schools in the "school" table with degrees present in the "degree" table. More specifically, the explicit indication of the relationship is to impose the restriction that the domain of the "schoolId" attribute of the "schoolDegree" table is not the integers, but the values currently existing in the "schoolId" attribute of the "school" table. This domain dependency relates to an important concept of relational databases, the term foreign key. The set of attributes whose domain consists of attribute values from other tables, usually the attributes that make up the primary key, is called a foreign key (Ramos, 2008).

4.1.2.2. Final result of Relational Model

According to the class diagram presented above, it was possible to design the following relational model. This model will not only support the system that imports data from the Fénix and provide it to the platform, but also translates the relationships between

tables that exist, enabling the crossing of student's relevant information in order to enhance studies related to academic success.

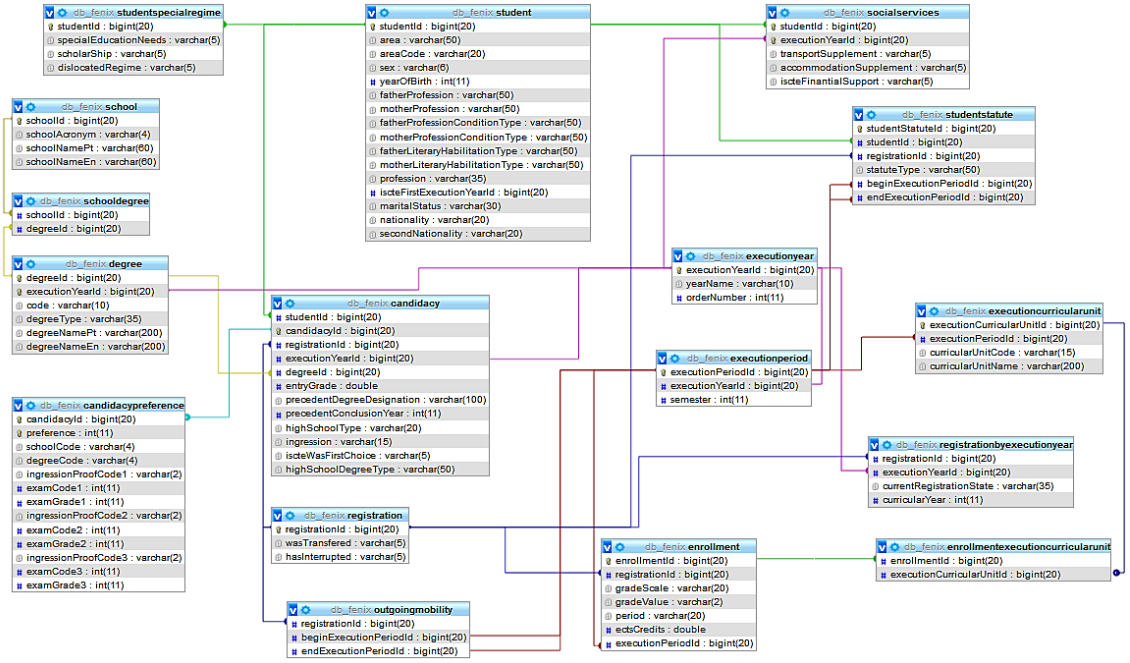


Figure 4.11- Relational model the platform's main database

To complement and contextualize the relational model, a table is exposed containing information regarding to the attributes of each table from the model.

Table	Attributes	Data types	Keys	Description	Notes
Student	studentId	bigint	<pk>	Student identification number	
	area	varchar(50)	---	Locality	
	areaCode	varchar(20)		Postal code/ Postcode/ Zip code	
	sex	varchar(6)		Sex	
	yearOfBirth	int		Year of birth	
	fatherProfession	varchar(50)		Father's profession	
	motherProfession	varchar(50)		Mother's profession	
	fatherProfessionConditionType	varchar(50)		Father's profession condition	
	motherProfessionConditionType	varchar(50)		Mother's profession condition	
	fatherLiteraryHabilitationType	varchar(50)		Father's educational qualifications	

	motherLiteraryHabilitationType	varchar(50)		Mother's educational qualifications	
	profession	varchar(35)		Student's profession	
	iscteFirstExecutionYearExternalId	bigint		Year of joining ISCTE-IUL	
	maritalStatus	varchar(30)		Student's marital status	
	nationality	varchar(20)		Student nationality	
	secondNationality	varchar(20)		Student second nationality	
StudentSpecialRegime	studentId	bigint	<pk>	---	
	specialEducationNeeds	varchar(5)	---	Special educational needs	True, if the student has special needs status.
	scholarShip	varchar(5)		Scholarship condition	True, if the student has any sort of scholarship (FCT or SAS)
	dislocatedRegime	varchar(5)		Dislocated regime	True, if on enrollment via DGES the student indicated that he was displaced
StudentStatute	studentStatuteId	bigint	<pk>	Student statute identification number	
	studentId	bigint	<fk1>	---	
	registrationId	bigint	<fk2>	---	
	statuteType	varchar(50)	---	Statute type designation	Ex: SAS or FCT grant owner, working student, partial time student, international student, etc.
	beginExecutionPeriodId	bigint	<fk3>	Execution period identification number that marks the beginning of the statute	
	endExecutionPeriodId	bigint	<fk4>	Execution period identification number that marks the end of the statute	
SocialServices	studentId	bigint	<pk, fk>	---	
	executionYearId	bigint	<fk>	---	
	transportSupplement	varchar(5)	---	Transport supplement	True, if the student has transport supplement
	accommodationSupplement	varchar(5)		Accommodation supplement	True, if the student has accommodation supplement
	iscteFinancialSupport	varchar(5)		Financial support from ISCTE-IUL	True, if the student has ISCTE-IUL financial support
Candidacy	studentId	bigint	<fk1>	---	
	candidacyId	bigint	<pk>	Candidacy identification number	
	registrationId	bigint	<fk2>	---	

	executionYearId	bigint	<fk3>	---	
	degreeId	bigint	<fk4>	---	
	entryGrade	double	---	Overall access grade	
	precedentDegreeDesignation	varchar(100)		Designation of the students' previous degree	
	precedentConclusionYear	int		Conclusion year of the students' previous degree	
	highSchoolType	varchar(20)		Type of school attended in high school	Ex: Public, private, both
	ingression	varchar(15)		Ingression or access type to higher education	Ex: General access regime, degree holder, etc.
	iscteWasFirstChoice	varchar(5)		ISCTE-IUL as 1st choice of access or not	True, if ISCTE-IUL was the student's first choice
	highSchoolDegreeType	varchar(50)		High school course or area	Ex: Scientific-Humanistic course, equivalence, etc.
CandidacyPreference	candidacyId	bigint	<pk, fk>	---	---
	preference	int	<pk>	Preference order number	---
	schoolCode	varchar(4)	---	Higher education institute code	---
	pretendedDegreeCode	varchar(4)		Pretended degree code	---
	ingressionProofCode1	varchar(2)		DGES Ingress exam code for higher education (1)	---
	examCode1	int		DGES exam code (1)	---
	examGrade1	int		exam grade (1)	---
	ingressionProofCode2	varchar(2)		---	---
	examCode2	int		---	---
	examGrade2	int		---	---
	ingressionProofCode3	varchar(2)		---	---
	examCode3	int		---	---
	examGrade3	int		---	---
Degree	degreeId	bigint	<pk>	Degree identification number	---
	executionYearId	bigint	<fk>	---	---
	degreeCode	varchar(10)	---	Degree code	---
	degreeType	varchar(35)		Degree type	Ex: Degree, master's degree, PHD degree, etc.
	degreeNamePt	varchar(200)		Degree designation (Portuguese)	---
	degreeNameEn	varchar (200)		Degree designation (English)	---
School	schoolId	bigint	<pk>	Identification number of a school in ISCTE-IUL	---

	schoolAcronym	varchar (4)	---	School acronym	Ex: ISTA, ECSH, EG, ESPP, IPPS, etc.
	schoolNamePt	varchar (60)		School full designation (Portuguese)	---
	schoolNameEn	varchar (60)		School full designation (English)	---
schoolDegree	schoolId	bigint	<pk, fk1>	---	---
	degreeId	bigint	<pk, fk2>	---	---
registration	registrationId	bigint	<pk>	Registration identification number	---
	wasTransfered	varchar (5)	---	Student was transferred	True, if was requested course transfer
	hasInterrupted	varchar (5)		Student has interrupted	True, if the course was interrupted
registrationByExecutionYear	registrationId	bigint	<pk, fk1>	---	---
	executionYearId	bigint	<pk, fk2>	---	---
	currentRegistrationState	varchar (35)	---	Registration state	Ex: Registered, interrupted, quitted, concluded, etc.
	curricularYear	int		Year of the degree in which it is registered	---
outgoingMobility	registrationId	bigint	<pk, fk1>	---	---
	beginExecutionPeriodId	bigint	<pk, fk2>	Execution period identification number marking start of outbound mobility	---
	endExecutionPeriodId	bigint	<pk, fk3>	Execution period identification number marking end of outbound mobility	---
enrollment	enrollmentId	bigint	<pk>	Enrollment identification number	---
	registrationId	bigint	<fk1>	---	---
	gradeScale	varchar (20)	---	Enrollment grade scale	---
	gradeValue	varchar (2)		Enrollment grade value	---
	period	varchar (20)		Enrollment period	---
	ectsCredits	double		Enrollment ects credits	---
	executionPeriodId	bigint	<fk2>	---	---
executionCurricularUnit	executionCurricularUnitId	bigint	<pk>	Curricular unit identification number	---
	executionPeriodId	bigint	<fk>	---	---

	curricularUnitCode	varchar (15)	---	Curricular unit code	---
	curricularUnitName	varchar (200)		Curricular unit name	---
enrollmentExecutionCurricularUnit	enrollmentId	bigint	<pk, fk1>	---	---
	executionCurricularUnitId	bigint	<pk, fk2>	---	---
executionPeriod	executionPeriodId	bigint	<pk>	Period identification number	---
	executionYearId	bigint	<pk, fk>	---	---
	semester	int	---	Semester designation	Ex: 1 or 2
executionYear	executionYearId	bigint	<pk>	Year identification number	---
	yearName	varchar(10)	---	Year name	Ex: 2010/2011
	orderNumber	int		Value to sort the years	---

Table 4.4- Attributes description of the platform's main database

Contextualizing some of the concepts and nomenclature that exists in the table that describes all attributes in the relational database model, more specifically, semantics regarding data types and keys follow the tables below.

Data types	Full Name	Meaning
int	Integer	It is a data type used to represent real numbers that do not have fractional values.
bigint	Big integer	Like the int data type, it is used to represent real numbers that do not have fractional values. However, the bigint data type is envisioned for use when integer values might exceed the range that is supported by the int data type.
double	Double	It is a data type used to represent real numbers that do have fractional values.
varchar	Variable character field	It is a data type which can contain any type of data: numeric, characters, spaces or punctuation. The current length of the variable character field can be anything from zero to the maximum declared field length.

Table 4.5- Attribute data types of the platform's main database

Keys	Full Name
<pk>	Primary key
<fk>	Foreign key
<pk, fk>	Primary key and foreign key

Table 4.6- Key attributes denomination present in the platform's main database

4.2. Secondary database conception

With the main database designed to support the Fénix system's academic data query, it is necessary to design a database that lists information from platform users and enables the establishment of login-based platform access control mechanisms. Being a login, a set of credentials used to gain access to the platform.

In addition to authorized user access control features, other user data is intended to be stored in such a way that each session of each user on the platform becomes unique and personalized. This information mostly concerns the query history of each user.

This need arises since there is no interest in embedding these functionalities in the main database purposes. From the point of view of managing and maintaining information systems, it would be less practical and more confusing.

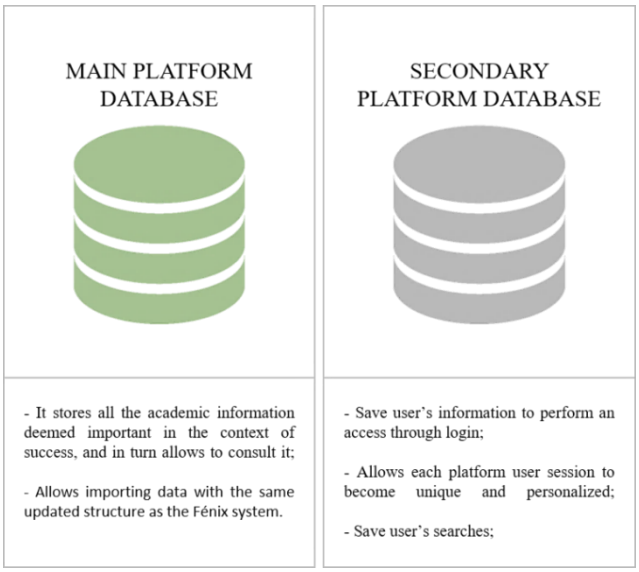


Figure 4.12- Databases comparison

The development of this database was followed by the same steps as the previous one. Initially, a UML class diagram model was designed, and then a relational model was designed.

4.2.1.1. Final result of Class Diagram

Since in the context of the development of the previous class diagram of the main database some theoretical concepts related to UML language were presented, in this model it will not be necessary, since both diagrams follow the same logic. However, all the structure of the diagram will be summarized and contextualized.

The following figure concerns the graphical representation of the class diagram designed.

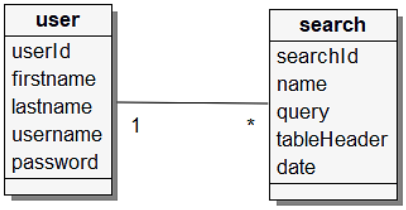


Figure 4.13- Class diagram of the platform's secondary database

The first impression, compared to the previous class diagram, is that this class diagram is much smaller and simpler. It only contains two classes and a relationship between them. The "user" class is intended to describe a set of objects (users) that share the same set of attributes (userId, firstname, lastname, username, password). And the "search" class therefore describes a set of objects (searches), also composed of a set of shared attributes (searchId, name, query, tableHeader, date).

The table below contains the description of the classes in this diagram.

Class	Description
user	Allows to represent and describe all users.
search	Represent and describe all searches.

Table 4.7- Descriptions of the classes in the secondary final diagram

As shown in the diagram, there is only one relationship between the classes. An association whose classification according to the upper bounds is defined by "one to many" and it reads as follows: A search can have only one user, and one user can have many searches. Which means implicitly that a search is necessarily associated with one and only one user.

4.2.1.2. Final result of Relational Model

Once again, during the conception of the relational model corresponding to the main database, fundamental concepts for its realization were approached. However, since this step covers exactly the same theoretical concepts as the other, only the whole structure of the relational model of the secondary database will be framed.

Considering the class diagram presented above, it was possible to design the following relational model.

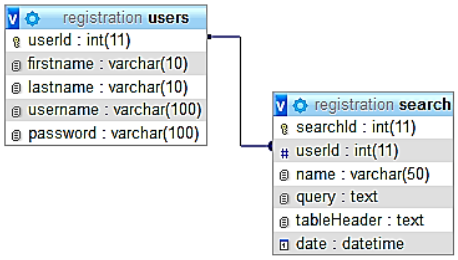


Figure 4.14- Relational model the platform's secondary database

This model supports the login system and platform user information management, as well as translates the relationships between existing tables, allowing information to be crossed between users and searches. Since the class diagram was simpler and smaller than the main database class diagram, this relational model is proportionally simpler. It is composed of only two tables, which are the user and search tables.

The following table contains information about the attributes of each table of this model.

Table	Attributes	Data types	Keys	Description	Notes
users	userId	int	<pk>	User identification number	---
	firstname	varchar(10)	---	User's first name	---
	lastname	varchar(10)		User's last name	---
	username	varchar(100)		User's institutional Email	Ex: example@iscte-iul.pt
	password	varchar(100)		User password	Each user's encrypted password
search	searchId	int	<pk>	Search identification number	---
	userId	int	<fk>	---	---
	name	varchar(50)	---	Search name	---
	query	text		SQL query performed on search	Each search will generate a table. Saving the table header and the SQL command used in the query easily replicates the query again in a search history.
	tableHeader	text		Table header generated in search process	
	date	datetime		Search date	---

Table 4.8- Attributes description of the platform's secondary database

Tables 4.5 and 4.6 presented above had the purpose of contextualizing the semantics referring to data types and keys present in the table of the attribute's description of the relational model. Part of the semantics prevails, mostly with respect to the keys, since they have exactly the same description. However, the following tables aim to add the different data types used in this relational model.

Data types	Full Name	Meaning
datetime	Integer	It is a data type used to represent real numbers that do not have fractional values.
text	Text	Stores any kind of text data.

Table 4.9- Attribute data types of the platform's secondary database

4.3. Databases implementation

After designing relational databases, a database management system (DBMS) is required. A DBMS is a system software that allows to create and manage databases. Within a relational database, there are relational model-based database management systems called as Relational Database Management Systems (RDBMS). In order to interact and communicate with the data stored in these systems, it is used the Structured Query Language (SQL), which is the default programming language for dealing with relational databases.

The system chosen to create and manage the relational database was MariaDB. Because it is a fast, scalable and robust open source relational database management system and because it provides an SQL interface for accessing data.

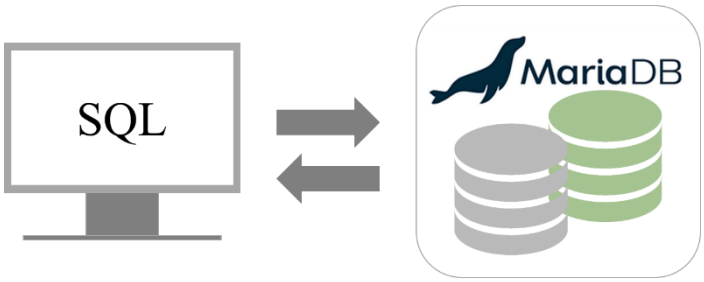


Figure 4.15- Database management system

Chapter 5 – The platform

Having the databases already implemented, the next steps are dedicated to the design and development of the platform. This next phase followed standard web application development practices such as choosing a software development lifecycle, using UML diagrams, and architectural and workflow drawings to explain and detail the system (Stobart & Parsons, 2008).

The development methodology implemented for the design of this platform was the software development lifecycle model called Waterfall. Which is a very popular, simple-to-understand software development architecture, often used for smaller projects with short duration where requirements are well known.

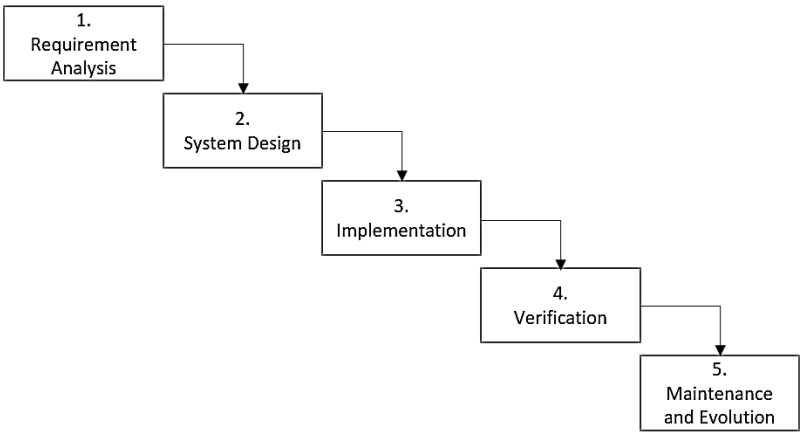


Figure 5.1- Used software development lifecycle model (Waterfall)

5.1. Requirements analysis

Similar to the collection of requirements for the design of the main database, which was carried out through the interviewing process, part of the requirements gathering process in this development lifecycle focused on the interviewees' perspectives and needs (also potential users). During this stage, the requirements were divided into two classes, functional and non-functional requirements. The first, respectively, are requirements that the end user specifically demands as basic functionality that the system must provide. These are basically stated user requirements that can be seen directly in the end product. In contrast, non-functional requirements, also called non-behavioral requirements, are basically the quality constraints that the system must meet according to the project scope, which essentially deal with issues such as security, performance, usability, portability, scalability, among others.

Id	Functional requirements description	Id	Non-functional requirements description
FR.1	The system should block a user access to information query areas if he is not logged in.	NFR.1	(Security) The system shall require a user to login using a username (institutional e-mail) and password.
FR.2	The system should block a user from access to information query areas if he does not have the necessary security credentials.	NFR.2	(Security) The system shall provide only one level of access: An authorized user level for unrestricted access to information query areas.

FR.3	An authorized user shall be able to have access to the predefined indicator sets query.	NFR.3	(Security) The system should ensure student anonymity by hiding any direct identification from students and using a minimal search result so that it is impossible to identify specific student cases.
FR.4	An authorized user shall be able to have access to a free survey that allows students to crosscheck information.	NFR.4	(Performance) The system shall be capable of supporting multiple connections from users.
FR.5	An authorized user shall be able to have access to all metadata information (designation and description of semantics, search results, etc.).	NFR.5	(Performance) The system shall be capable of supporting multiple queries from each user at the same time.
FR.6	An authorized user shall be able to export search results in excel compatible format.	NFR.6	(Usability) The system must allow the user to easily understand the use and options of the tool.
FR.7	An authorized user shall be able to save searches.	NFR.7	(Usability) The system must be user friendly and intuitive.
FR.8	An authorized user should be able to access a saved search history.	NFR.8	(Portability) The system shall be capable to achieve browser combability.
FR.9	An authorized user must have access to the personal information and have the option to change password.	NFR.9	(Scalability) The system shall be capable to allow database upgrades.

Table 5.1- Functional and non-functional requirements

5.2. System design

At this stage, system design and architecture are designed to meet the needs of end users. As such, use case diagrams are initially used as they are often used as a first approach to modeling a system. And finally, a proposal is presented to the system architecture.

5.2.1. UML Use case diagram

In addition to what was mentioned earlier in the database design chapter, UML is one of the object-oriented solutions used in software modeling and design. UML can also be designated as a general-purpose visual modeling language for building, documenting, and specifying a software system. Previously, structural diagram was used, more specifically UML class diagram, because it was the best suited for the task. However, for this phase, it was used a behavioral diagram, precisely, the UML use case diagram. Which allow to represent the desired behavior of a system (requirements), regardless of how the system will be implemented. Essentially, use case diagrams provide an overview of system resources (services) and how they interact with Actors (users). Indicating the main features of the system and delimiting the border (external users).

5.2.1.1. Use case

Briefly, a use case is a description of a sequence of actions that the system takes to meet an actor's goals. Each use case should have a distinct name that easily associates it with actions performed by the system.

Figure 5.2- UML use case examples

In addition, use cases may contain in their description a more or less exhaustive set of functional requirements described through structured language (goals, conditions, sequence, triggers, etc.).

5.2.1.2. Actors

An actor specifies a role played by a user or any other entity that interacts with the system. In this context there is only one actor engaging with the system, who is also classified as the main actor, because it uses the system in order to achieve a goal. The actor in this system is a user who needs special authorization to allow him to access web application resources. This authorization is due to the fact that the information contained in the web application is sensitive and critical. This system should only be used by users who will make correct use of the data, in the sense that they will not attempt to take advantage of the system for negative practices such as the purpose of identifying and exposing particular student cases.

5.2.1.3. Final result of Use Case diagram

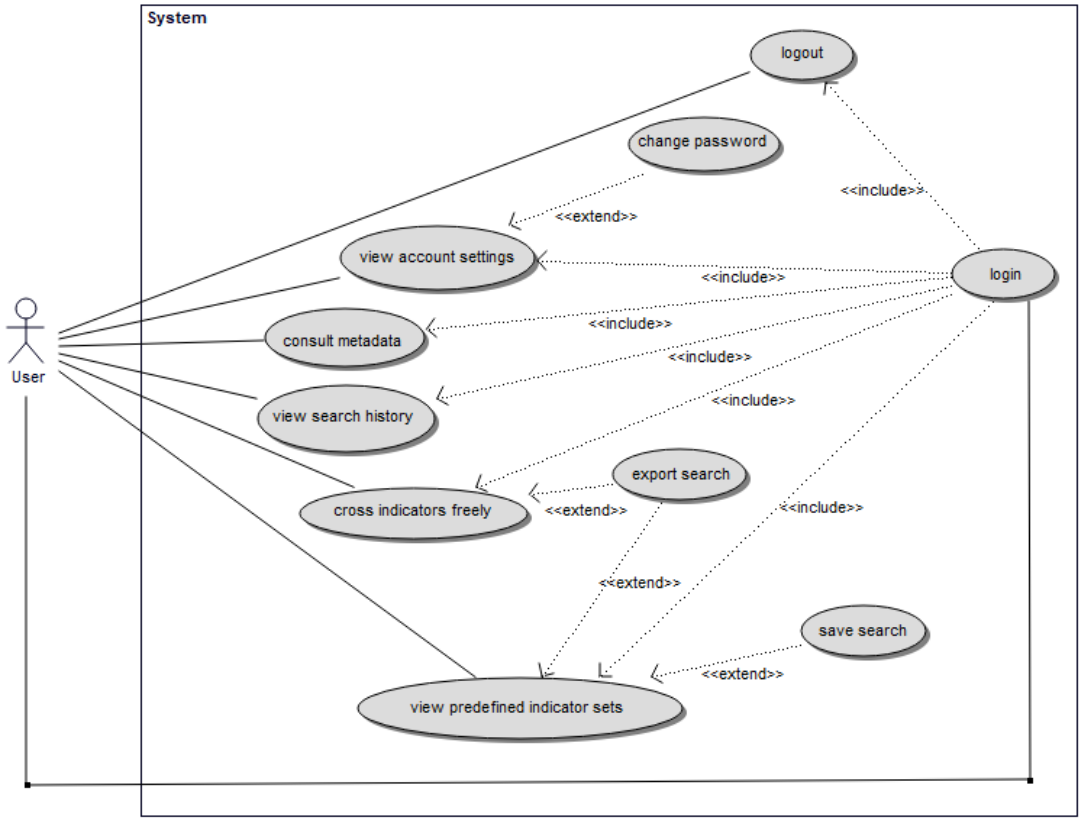


Figure 5.3- UML use case diagram

5.2.1.4. Use cases description

The following tables refer to the description of the use cases presented in the diagram, by structured language based on the following topics: goal in context, preconditions, trigger.

Use Case	Login
Goal in context	Enable the user access to the system
Preconditions	The user has a valid username and password and is not already logged in
Trigger	The user requires access to the system to perform academic data consult

Table 5.2- "Login" Use case description

Use Case	Logout
Goal in context	Disable the user access to the system
Preconditions	The user is already logged in
Trigger	The user no longer requires access to the system to perform academic data consult

Table 5.3- "Logout" Use case description

Use Case	View account settings
Goal in context	Check the account settings
Preconditions	The user is already logged in
Trigger	The user access to the account settings page

Table 5.4- "View account settings" Use case description

Use Case	Change password
Goal in context	Change the old password to a new one
Preconditions	The user is already logged in
Trigger	The user chooses through the account settings page to change the password

Table 5.5- "Change password" Use case description

Use Case	Consult metadata
Goal in context	See the metadata related to the academic data available for consultation in the system.
Preconditions	The user is already logged in
Trigger	The user access to the metadata page

Table 5.6- "Consult metadata" Use case description

Use Case	View search history
Goal in context	View history of all saved searches
Preconditions	The user is already logged in
Trigger	The user access to the search history page

Table 5.7- "View search history" Use case description

Use Case	Cross indicators freely
Goal in context	Cross indicators related to the academic data available in the system.
Preconditions	The user is already logged in
Trigger	The user access to the free query page

Table 5.8- "Cross indicators freely" Use case description

Use Case	Save search
Goal in context	Save a search after crossing information
Preconditions	The user is already logged in
Trigger	The user chooses through the free query page to save the search done

Table 5.9- "Save search" Use case description

Use Case	Export search
Goal in context	Export a search after crossing information or after consulting predefined academic indicator sets
Preconditions	The user is already logged in
Trigger	The user chooses, through the predefined indicator sets page, or through the free query page, to export the search performed.

Table 5.10- "Export search" Use case description

Use Case	View predefined indicator sets
Goal in context	Consult predefined academic indicator sets related to the data available in the system.
Preconditions	The user is already logged in
Trigger	The user access to the predefined indicator sets page

Table 5.11- "View predefined indicator sets" Use case description

5.2.2. System architecture

To design a system architecture, all intended functionality in the system has been taken into account. But factors such as service integration were also taken into account. It follows that the best solution to meet all project requirements would be to implement a web application.

Therefore, the entire structure and architecture of the system was focused on the systems integration required to implement this type of application software. A web application is a software application that runs on a remote server. In most cases, web browsers are used to access web applications on a network, such as the Internet. In this particular scenario, the web server will be local for security and testing purposes and will communicate with the web browser through the user interface, as well as the web application. The user interface is the interface through which the user accesses through his web browser. Finally, and in order to integrate the main functionality of the system (make data available for consultation), the web application will communicate with the databases.

The following figure is the graphical representation of the architecture proposed for the design of this system.

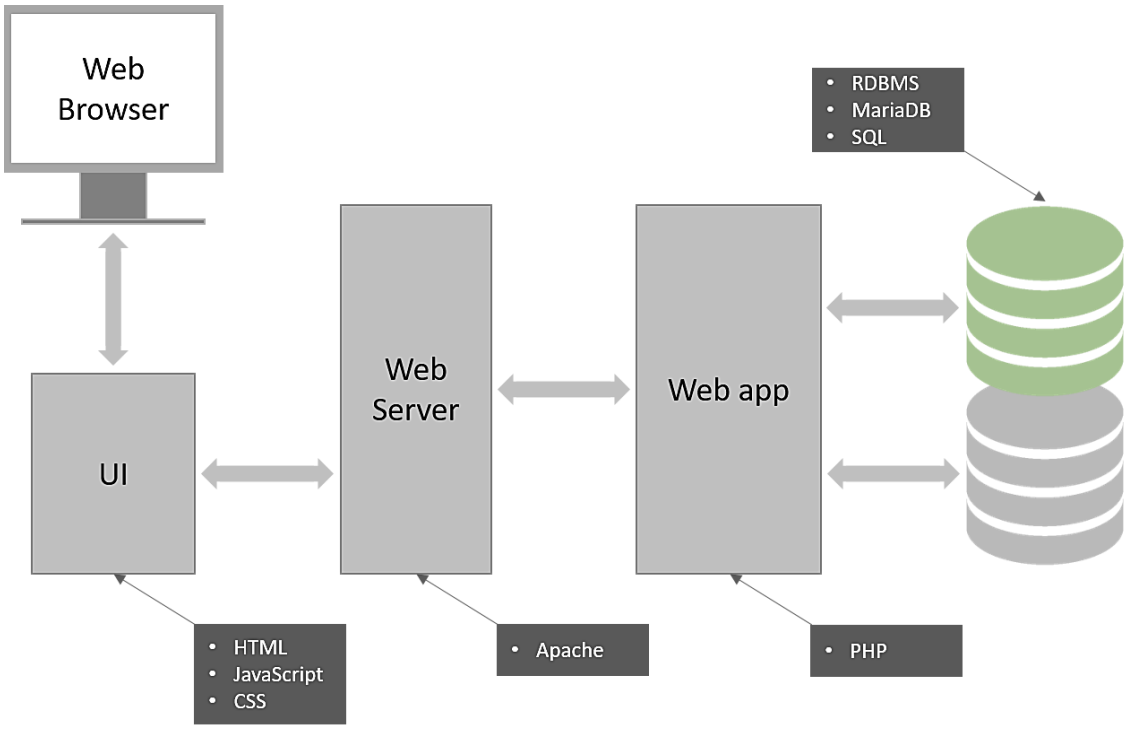


Figure 5.4- System architecture

5.3. System implementation

As the previously defined system architecture suggests (figure 6.4), this web application implementation is essentially divided into two base processes: front-end and back-end development.

5.3.1. System front-end and back-end

The front-end (UI) refers to the presentation layer of a web application. Also called the client side, it includes everything the user views and experiences with direct contact, from images, navigation menus, text, colors, buttons, among others. In this front-end

process, three languages were used, namely: HTTP, CSS and JavaScript. HTML refers to the Hypertext Markup language and is used for creating web pages and applications since it is the backbone of the web. Hypertext is for hyperlinks that an HTML page may involve, and markup language refers to the way tags are used to define and care for the page's layout, structure, content, and in short, it is what controls the appearance of HTML on the page. CSS aims to define the colors, fonts styles, layouts, background images, margins, sizes, and even how the page and page content are organized, among many other related functions. JavaScript is an essential language of the front-end development. JS is widely used to improve user communication with the web page by allowing to create and control dynamic content, adding more interactivity and enhancing more complex animations.

The back-end (server side) allows to create components and features that are accessed indirectly by a user through a front-end application. Succinctly, is the part of the web application that the user does not see, and which is accountable for ensuring that everything on the user interface really works, including the management and interaction of information systems (databases). For the backend development process, two languages were used, namely: PHP and SQL. PHP stands for Hypertext Preprocessor and is a general-purpose scripting language that is especially suited for web development because it offers incredible versatility when developing a dynamic web application. It also allows for fast and secure database access, as PHP is embedded in HTML before page loading, and hidden from the user. SQL refers to Structured Query Language and is an incredibly powerful language that can be used to search, modify and even create databases over relational database servers such as MariaDB, MySQL, Microsoft SQL Server, etc.

In order to integrate all the intended architecture in accordance with the presented languages and systems, XAMPP was used. Which is an open source cross-platform web server solution package consisting primarily of the Apache HTTP server, MariaDB database, and script interpreters written in various programming languages, including PHP, in a complete package.

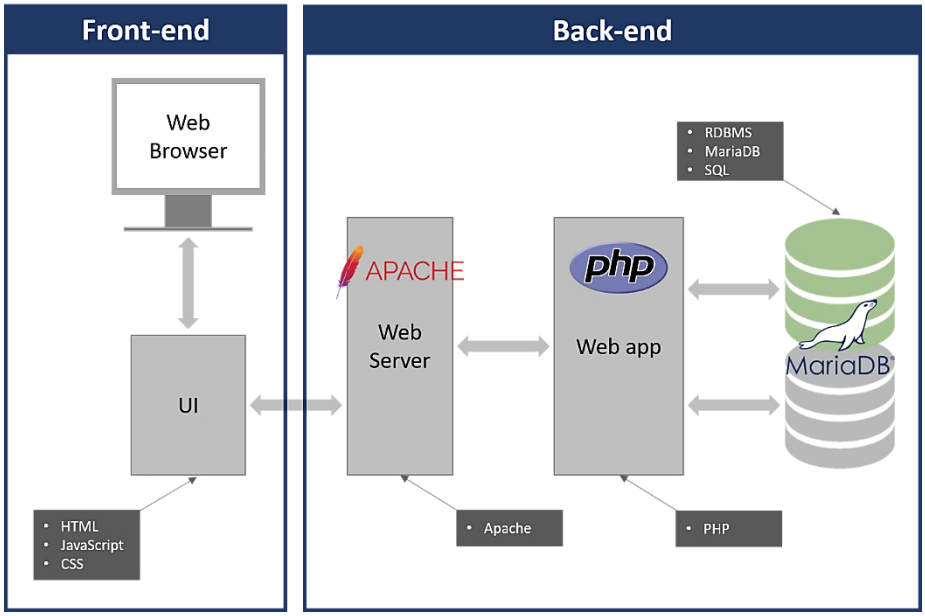


Figure 5.5- Front-end and back-end implementation approach

The implementation of the system went through the development of the user interface and back-end simultaneously.

Initially, Fénix system was used as a graphical aid for the development of the user interface, in order to closely resemble the user experience in both services. And so that if possible, try to convey the feeling to the user that the service is an extension of the Fénix. These similarities are most visible in structure, navigation menus, colors, and logos.

Figure 5.6- Fénix initial navigation menu

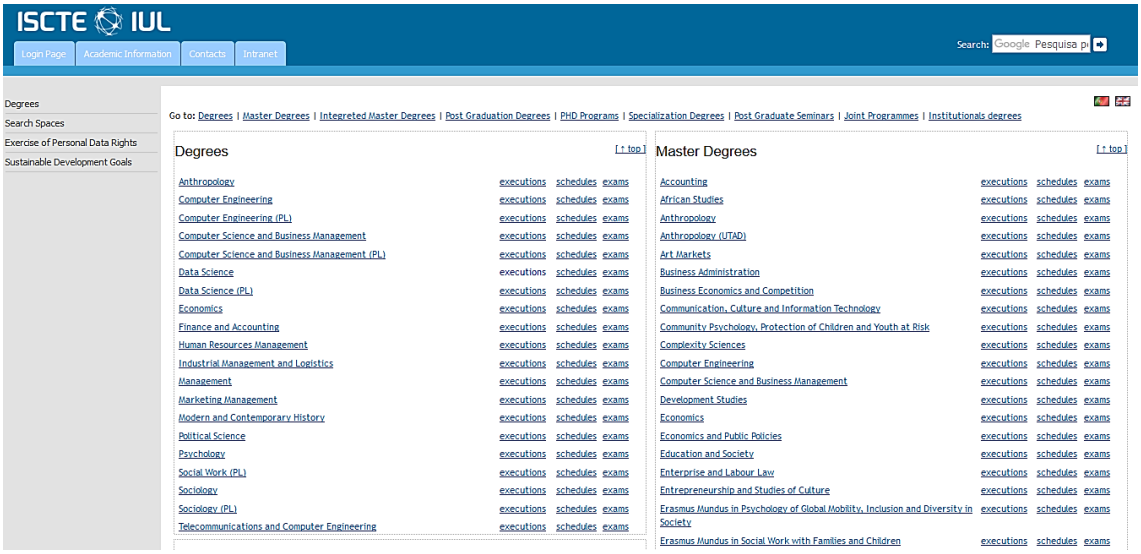


Figure 5.7- Fénix initial page

5.3.2. Before login UI

Development began by focusing on the UI before the user established a login. Being the result of the UI menu layout before the user logs in, a composition between login, mission, and team pages.

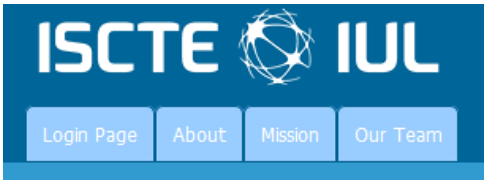


Figure 5.8- UI initial navigation menu

With a very simple and intuitive functionality, allows clicking on each of the buttons included in the menu will allow navigation and forwarding between the different pages. Each page aims to highlight different points.

5.3.2.1. About page

As illustrated in the figure below, aims to focus and explain which service is offered by the application.

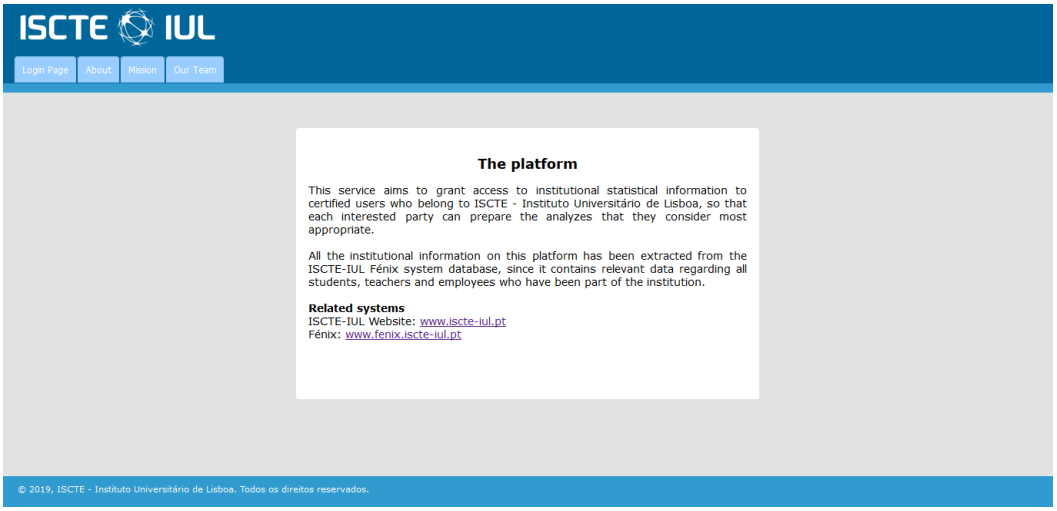


Figure 5.9- UI about page

5.3.2.2. Mission Page

As the picture below illustrates, the mission page frames the purpose and motive of the platform as well as the context of the mission. as illustrated in the following figure.

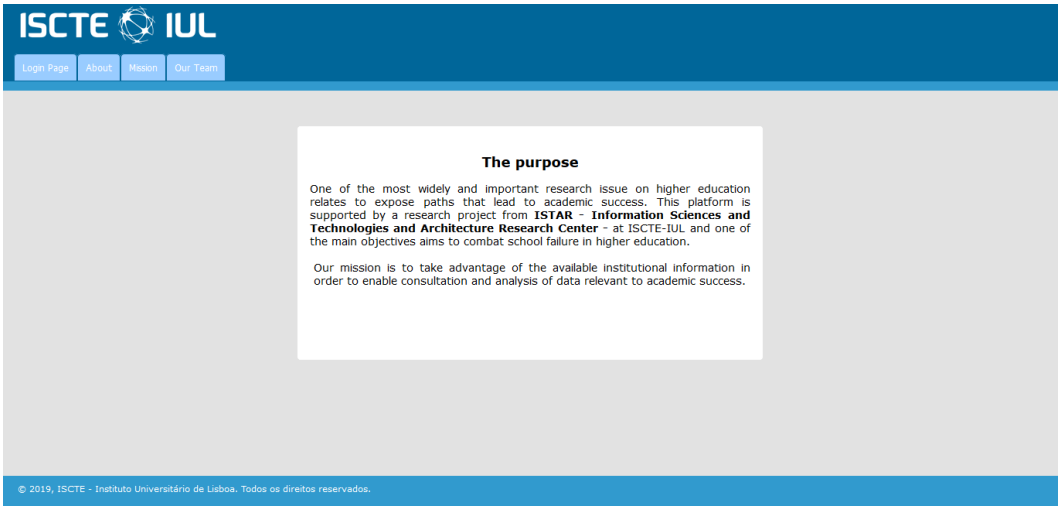


Figure 5.10- UI mission page

5.3.2.3. Team page

Then, the team page, called "our team", provides information about each project member through a simple click on each photograph. The information is not only in terms of curriculum, but also taking into account the positions held by each member during the project. Below are the figures for the team page and an example of browsing that page.

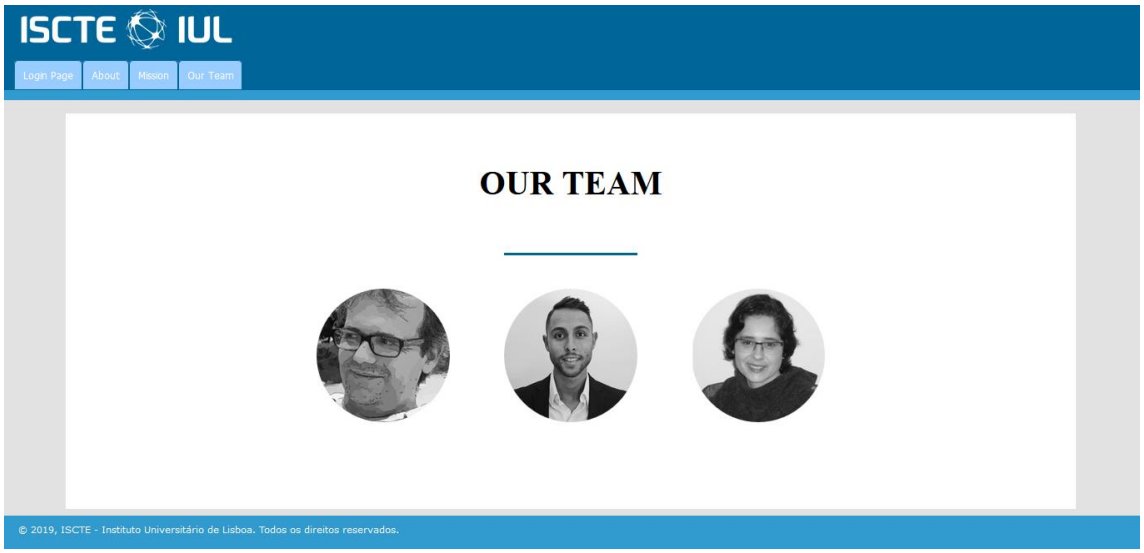


Figure 5.11- UI team page

Figure 5.12- UI team page (example)

5.3.2.4. Login page

Last but not least in this menu, the login page. A bit more demanding in terms of implementation than the others because it offers a login form that aims to verify the user's access credentials.

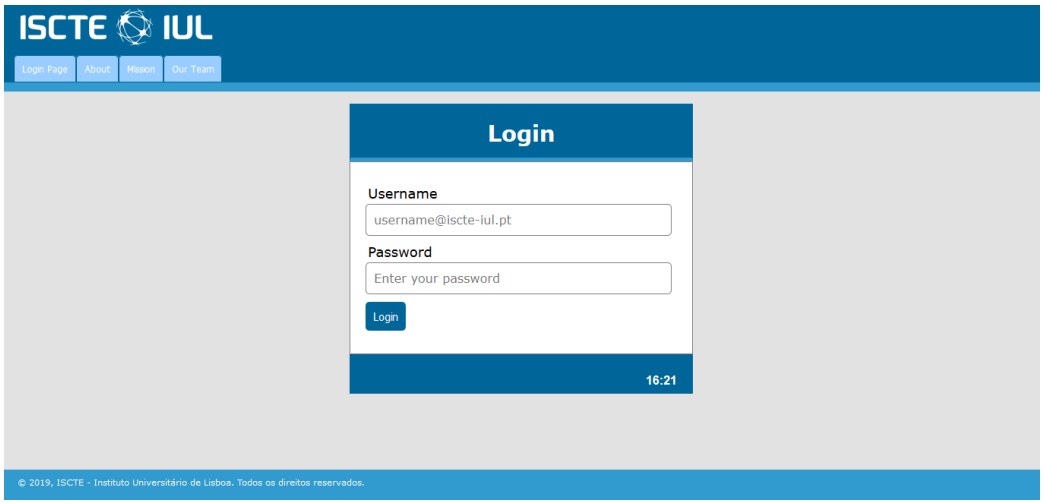


Figure 5.13- UI login page

5.3.2.4.1. Form rules

In the first contact with the form the user notices that it is mandatory to fill in the username field before submitting the login.

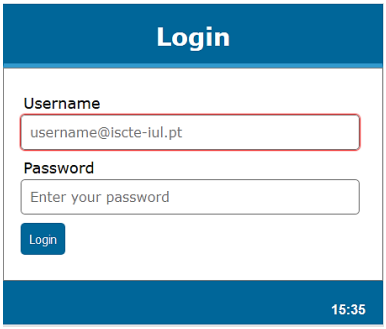


Figure 5.14- before login (username mandatory)

As a prevention, it is not enough for the user to enter any username. Regardless of whether the credentials are later valid or not, the form requires the username to be an "@iscte-iul.pt" e-mail.

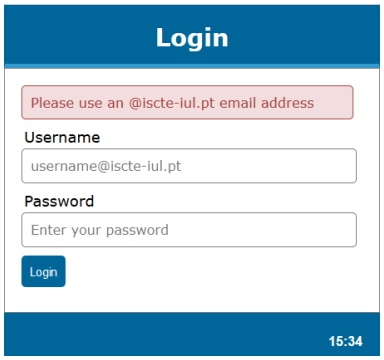


Figure 5.15- Before login (exclusivity in the username domain)

And it is implied that, it is not enough to fill a valid username to execute the login, it is always necessary to enter a password.

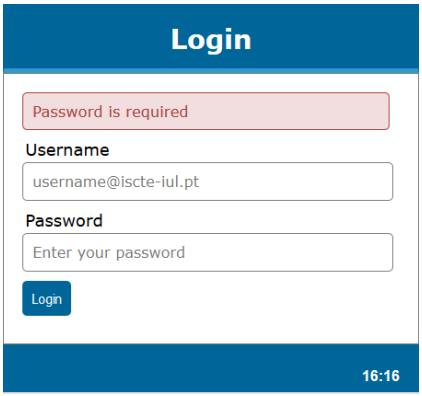


Figure 5.16- Before login (password mandatory)

5.3.2.4.2. Login submission

After inserting the username, password and form submission comes the phase that requires greater rigor and more development. There are two possible result scenarios for page login submission: login success or failure.

5.3.2.4.2.1. Login failure

Failure to login implies that the username and password combination is not valid. That is, there is no record in the database intended for user data, with such a combination of username and password.

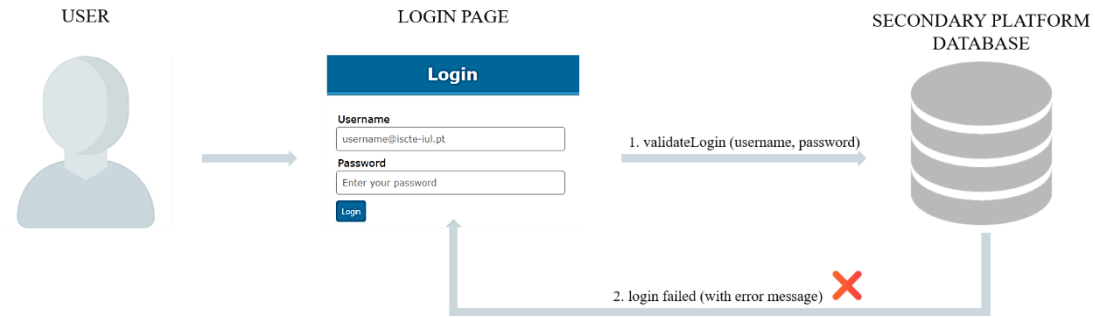


Figure 5.17- Login submission (login failure sequence)

The system does not specify whether the error is in username or password. It just spells out the message illustrated in the following figure.

Figure 5.18- Login submission (failure form)

5.3.2.4.2.2. Login successful

Successful login implies that the combination of username and password is valid as it is in the secondary database which contains all system user records. As illustrated in a sequential figure below.

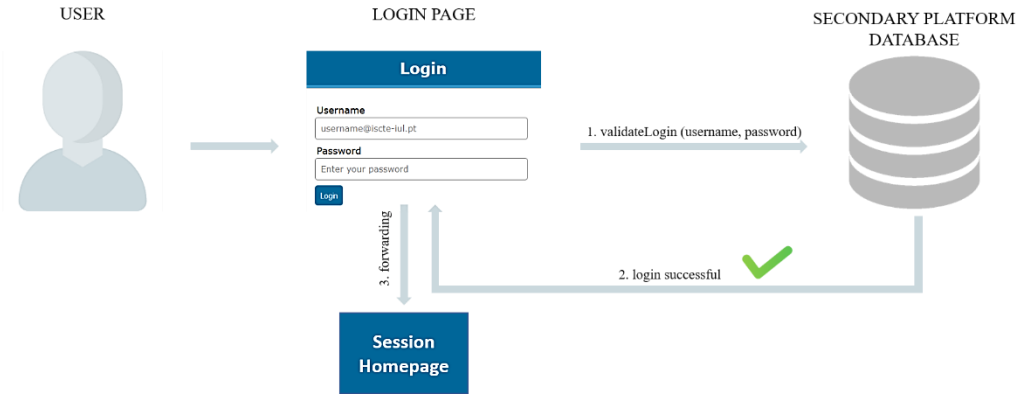


Figure 5.19- Login submission (login successful sequence)

As shown in the figure representing the login sequence, valid and successful login routes the UI to a user session. And from the session comes a navigation menu, different from the previous one, which allows exclusive functionality to an authorized user.

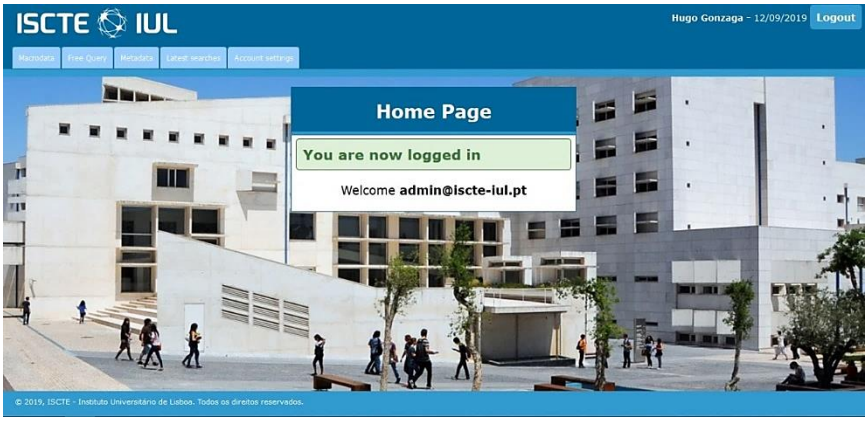


Figure 5.20- login submission (login successful destination page)

5.3.3. After login UI

As stated earlier, after the accredited login, the user has features that focus on the project's objectives and core requirements. The logic of login lies in the fact that not all users will have access to these features. The web application has a lot of sensitive academic information and can only be accessed if a user is authorized to do so.

These features are arranged in a main navigation menu, identical to the previous one regarding to the usability and graphics. And it consists of the following items: macrodata, free query, metadata, latest searches and account settings.

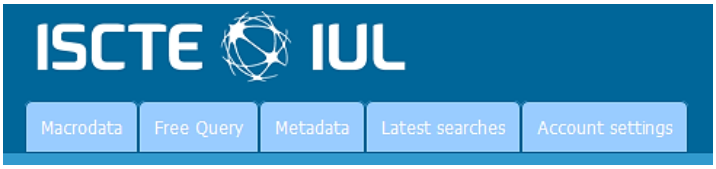


Figure 5.21- UI main menu

5.3.3.1. Macrodata

Starting with metadata, it aims to provide searches over a set of pre-defined indicators within the context of higher education as well as academic success.

5.3.3.1.1. Macrodata front-end

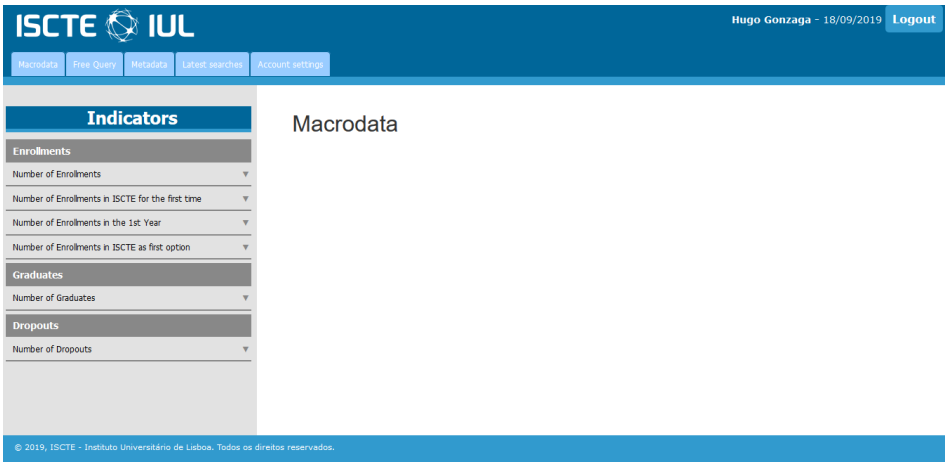


Figure 5.22- UI macrodata

In this feature, the DGEEC, PORDATA and Eurostat platforms were used as reference for the design of indicators. In one of the previous chapters, more precisely the state of the art, the arrangement of some indicators included in each of the platforms was presented.

The following table shows the result of the indicators established based on those found in the platforms.

Enrollments	Number of enrollments	per year per year and sex per year and nationality per year and degree school per year and degree type
	Number of enrollments for the first time	
	Number of enrollments in the 1st year	
	Number of enrolments in ISCTE as first option	
Graduates	Number of Graduates	
Dropouts	Number of Dropouts	

Table 5.12- Macrodata established indicators

The following figure refers to the result applied to the user interface. To include indicators, a side navigation menu consisting of subgroups has been developed to allow easy interaction between the user and the service.

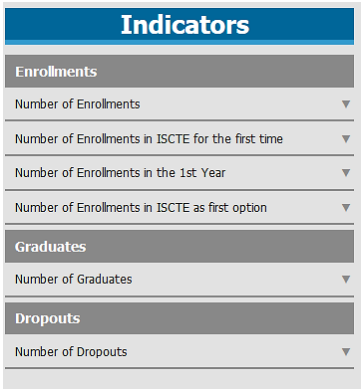


Figure 5.23- UI macrodata established indicators

Subgroups by definition are hidden to allow less confusing navigation. However, with a simple down arrow click, they emerge.

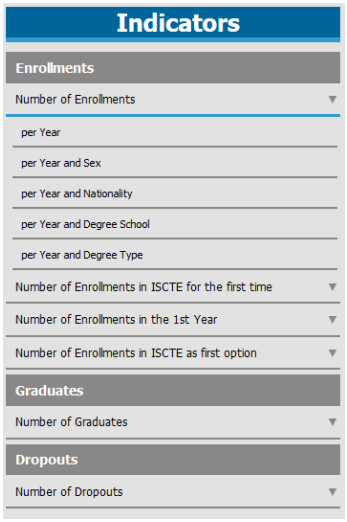


Figure 5.24- UI macrodata established indicator subgroups

Like the other platforms, searches performed on this feature are returned in the form of a table, with the export to excel function always associated. As the following example illustrates.

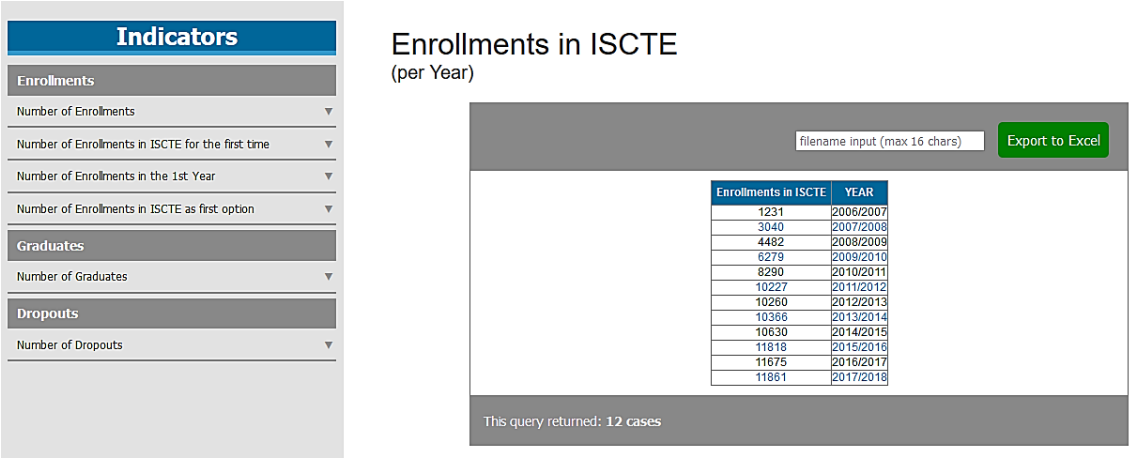


Figure 5.25- UI macrodata search example

5.3.3.1.2. Macrodata back-end

Concerning consulting the macrodata page indicators, there is some development that is not "in sight" of the user. Each search involves routing to a new page, with the same structure as the macrodata, and which has included a php script that establishes a connection to the main database, generates an SQL query to perform the search and also draws the result table. Each of the indicators combined with one of the subgroups form a different search, i.e. different SQL query. Resulting in total 30 different fixed queries.

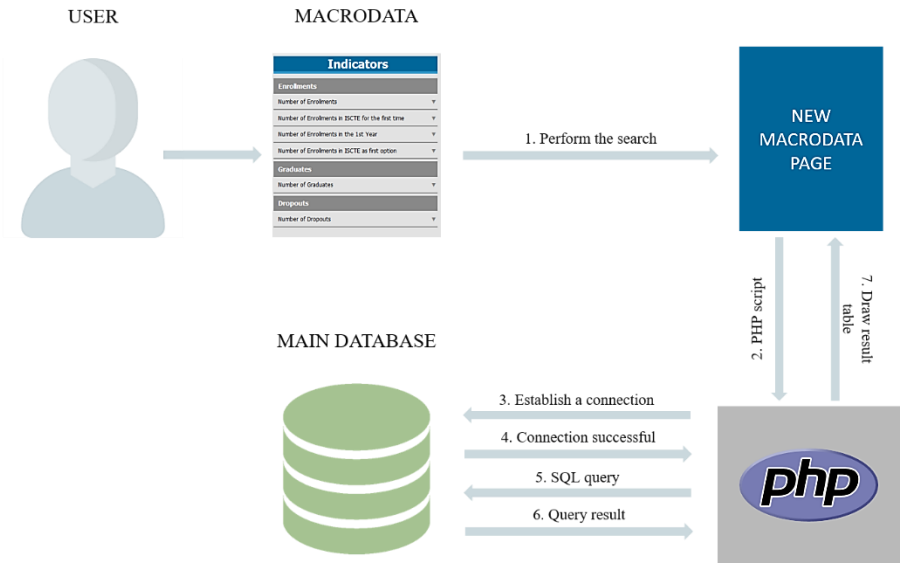


Figure 5.26- Macrodata back-end

5.3.3.2. Free query

The free query is the main functionality of this system, since it aims to make it possible to cross-reference a set of student data. All available data were those considered relevant during the requirements gathering and database design, in the context of finding new standards and paths of academic success.

5.3.3.2.1. Free query front-end

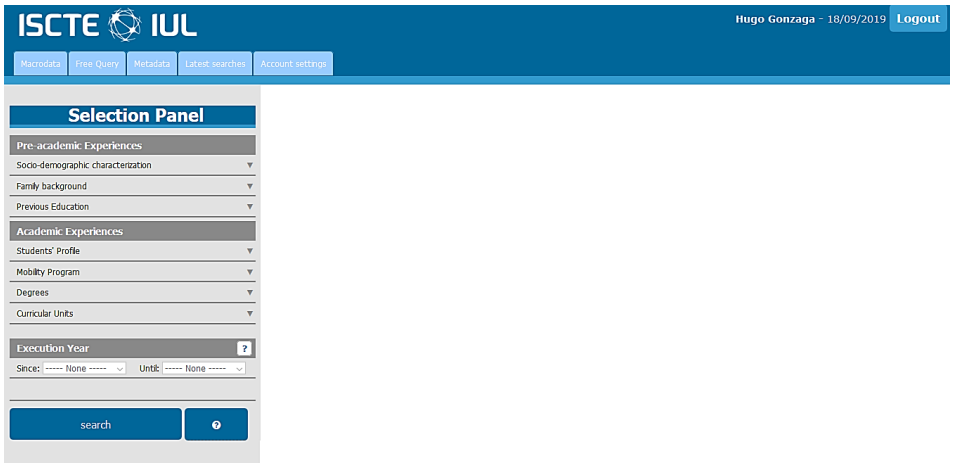


Figure 5.27- UI free query

This feature, like the previous one, was arranged in a vertical side navigation menu, with the difference that the content is totally dissimilar as well as the purpose. The structure is defined as a selection panel, in which each main title (pre academic and academic experiences) involves a set of dimensions, and each dimension a data set.

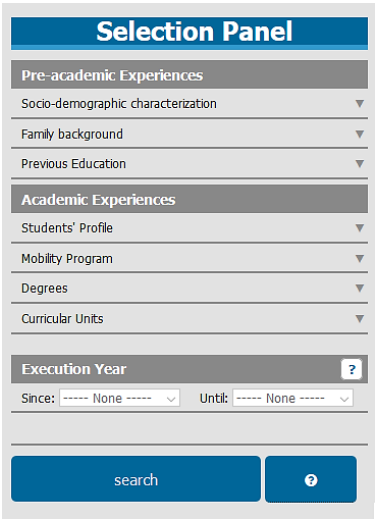


Figure 5.28- UI free query selection panel

Each data set of each dimension by definition is hidden, yet expandable. All of these sets are represented and can be flagged or related through the checkbox. These features are visible in the following image.

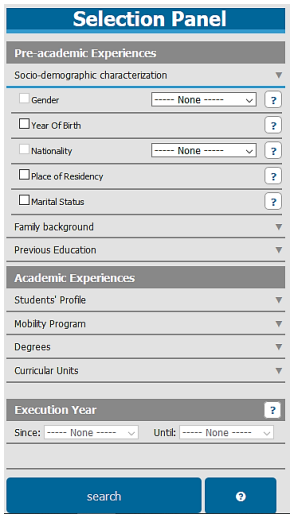


Figure 5.29- UI free query selection panel (dimension)

Some have in addition to the checkbox, a selection filter to provide filtering at the time of the search and to create more dynamic search execution. An example of this is illustrated in the figure below.

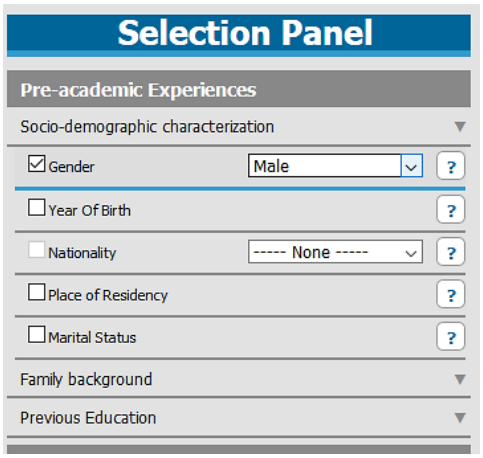


Figure 5.30- UI free query selection panel (variables)

In addition to features directly related to the selection itself, there is a help tip for each variable ("?"), Which provides a brief description of the variable, as shown in the following figure.

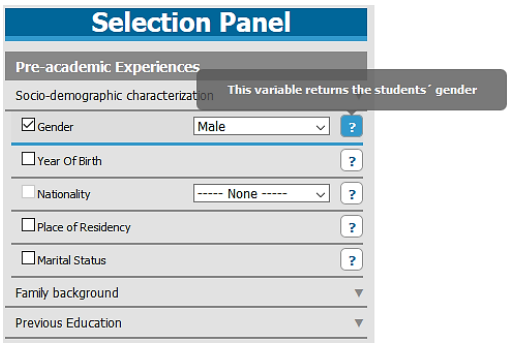


Figure 5.31- UI free query selection panel (variables help tips)

Another possibility different from the others is that it is possible to change the range of years over which the selected variables are to be consulted. To do this, there must be at least one variable that has any relation to the year in order to unlock the range selection panel.

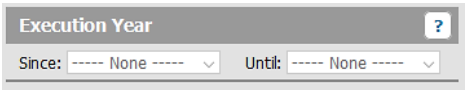


Figure 5.32- UI free query selection panel (execution year, locked)

Once unlocked, this panel is shown as the following illustration demonstrates.

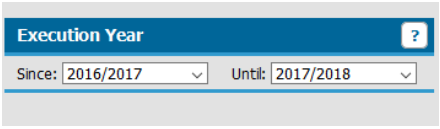


Figure 5.33- UI free query selection panel (execution year, unlocked)

The last tool options are specifically the search launch button and a tool help tip.

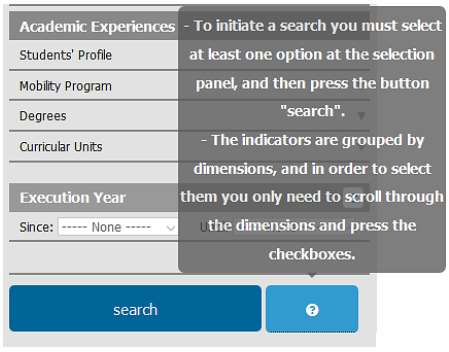


Figure 5.34- UI free query selection panel (search button and tool help tip)

The following table represents the complete structure used for the design of this tool, in terms of dimensions and variables.

Pre-academic experiences	Socio-demographic characterization	Sex
		Year of birth
		Nationality
		Place of residency
		Marital status
	Family background	Parents' education
		Parents' job
	Previous education	High school type
		High school degree type
		Precedent degree
		Precedent degree conclusion year
		Ingression type
		Entry grade
		Iscte was first choice
Academic Experiences	Students' profile	Statute
		Displaced
		Special education needs
		Scholarship
		Transport supplement
		Accommodation supplement
		ISCTE-IUL financial support
		Registration state
		Was transferred
		Has interrupted
	Mobility program	Student outgoing
	Degrees	Degrees' designation
		Degrees' type
		Degrees' school
	Curricular Units	Curricular units' codes, names and execution periods
		Grades and ects credits

Table 5.13- UI free query structure

As well as in the macrodata functionality, these microdata queries are returned in the form of a table, with the export to excel function, plus the additional option to save the query. As the following example illustrates.

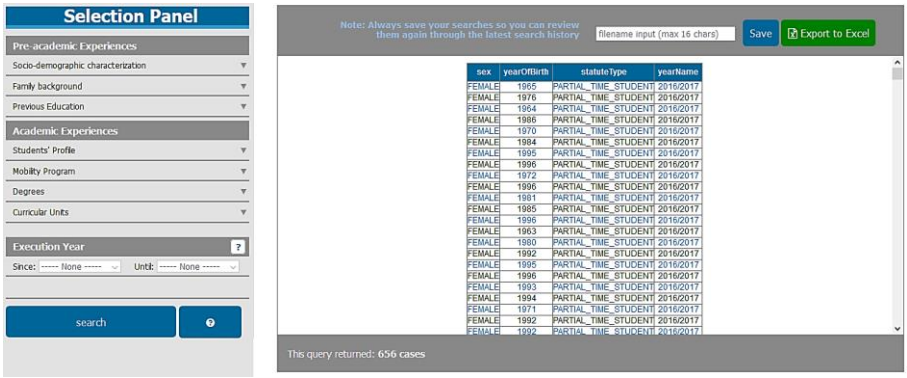


Figure 5.35- UI free query example

5.3.3.2.2. Free query back-end

This functionality should be one of the most complex, if not the most complex in terms of backend development. Each query executed starts a PHP script that receives as input all the selection made by the user and translates all that selection into an SQL query. Later the connection to the main database is established, the translated SQL query is executed, and all the results are reproduced in the form of a table.

The following illustration is a good representation of the sequence and flow of coding and performance of functionality.

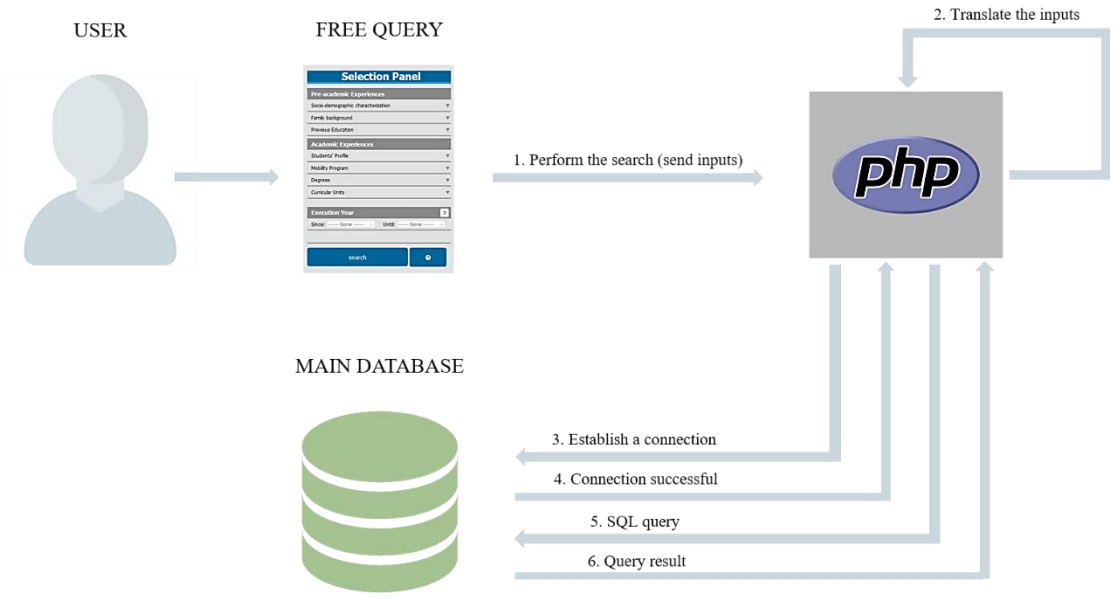


Figure 5.36- Free query back-end

Once the search result is available, there is the option to save and export as mentioned above. However, both are quite different in terms of development. The export function is through JS and simply reproduces the UI table in excel compatible format. The save function involves backend development. Because it consists of saving the search that the user performed in the secondary database, for later the "last search history" functionality to have access. For this, it is necessary that when clicking on the button, a PHP script is executed in order to receive and to the necessary inputs to save a search in the database, specifically the name of the search (if it has), the executed SQL query, the header of the table and the date of the search. And finally forward the session to the latest searches page.

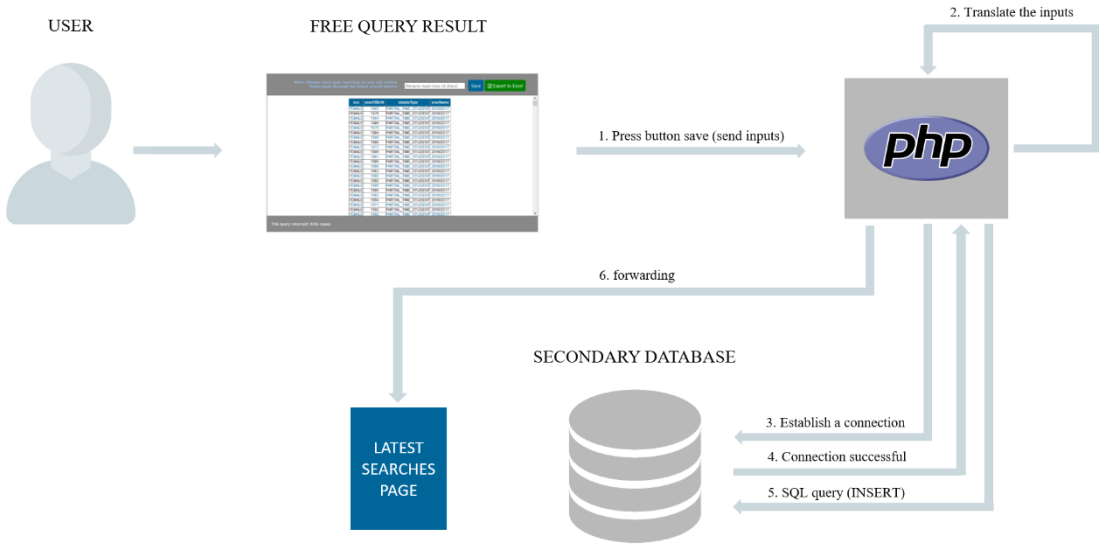


Figure 5.37- Free query back-end (save button)

Since one of the most important requirements of the system was to ensure the preservation of student anonymity, at least two restrictions have been incorporated into this free query functionality. One of the restrictions makes it impossible to cross-check data that directly identifies the student, such as student identification numbers, candidacy identification numbers, registration identification numbers, etc. And since just one constraint is not entirely sufficient, the other restriction works at the minimum level of possible results. So that this limit could be easily accessed and changed, an administration table, called “queryManagement”, was created in the main database. This table contains as one of its attributes the minimum result value ("queryLowerLimit"), which is queried for each free query search. The following figure refers to the new management table in the relational model of the main database.

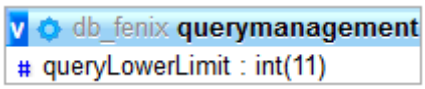


Figure 5.38- New table in free query scope (queryManagement)

When the search does not return the minimum results, the following message appears.

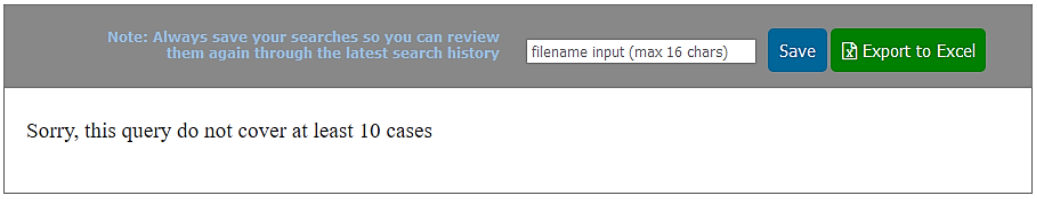


Figure 5.39- Free query restriction (lower limit)

5.3.3.3. Metadata

Metadata is a very important feature for this system. Since it describes and supports information regarding each variable present. Not only from the point of view of semantics but also in terms of the possible results of each variable. It therefore has a contextualization potential associated with the main web application tool.

5.3.3.3.1. Metadata front-end

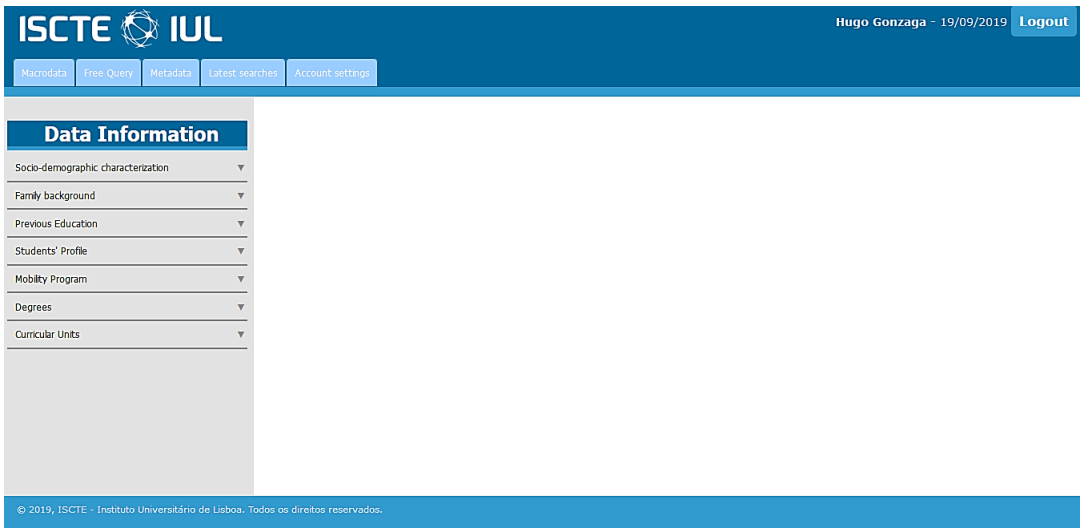


Figure 5.40- UI metadata

Like the other features, the menu structure was designed on the side with a vertical navigation, with the purpose of reserving the central space of the page for the contents to be presented of each variable of dimensions.

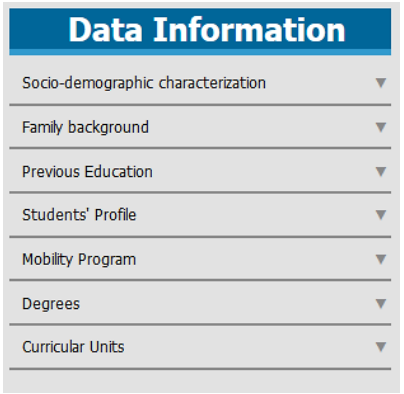


Figure 5.41- UI metadata menu

Since the contextualization is centered on the variables contained in the free query tool, the structure presented in this menu is very similar, as well as the use and expansion behavior of the components. Because it uses exactly the same dimensions and each dimension contains the same variables. Thus, it becomes somewhat redundant to present the complete structure again, as it was mentioned in a table above (table 6.13).

A representative example of the use and disposition of information is illustrated in the following figure.

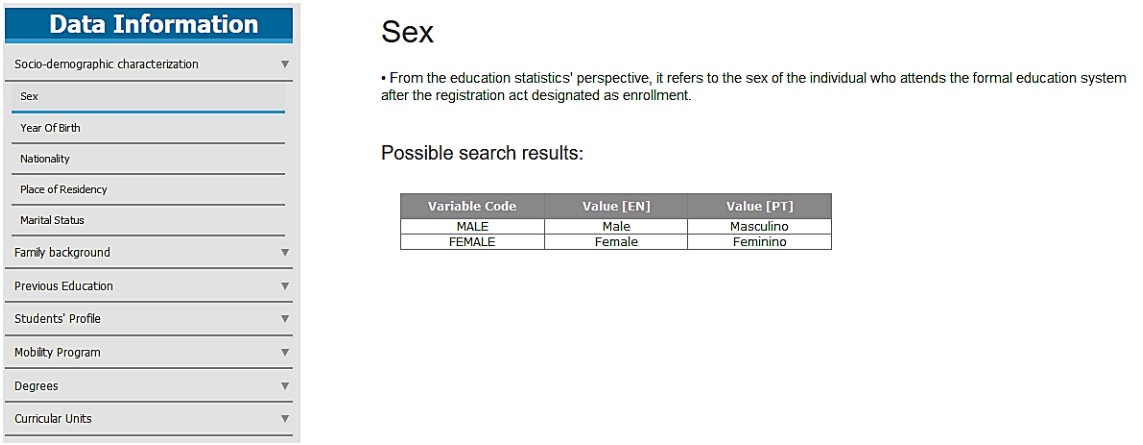


Figure 5.42- UI metadata example

5.3.3.3.2. Metadata back-end

This feature did not require major backend development. It was only necessary for some of the tables regarding the possible results of the variables. Some of these tables were generated using a PHP script that allows the connection to the main database to be established, and the execution of an SQL query in order to return the table with the possible results and its contextualization. Others with simpler character are simply drawn in HTML.

In order to facilitate this process, as the database implicitly contained all possible results of each variable, it was considered appropriate to create a new table in the main database, called auxEnum, concerning the contextualization of some of the possible results. of some variables. The following figures show the representation of the new table in the relational database model and examples of data in the table, respectively.

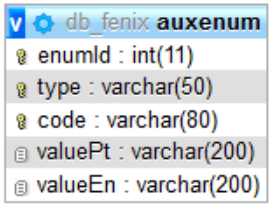


Figure 5.43- New table in metadata scope (auxEnum)

enumId	code	type	valuePt	valueEn
2	MALE	Gender	Masculino	Male
3	FEMALE	Gender	Feminino	Female
4	UNKNOWN	ProfessionConditionType	Desconhecido/Não tem	Unknown/Doesnt have one
5	DEPENDENTE_WORKER	ProfessionConditionType	Trabalha por conta de outrem	Employed Person
6	INDEPENDENTE_WORKER_EMPLOYEES	ProfessionConditionType	Trabalha por conta própria - (como empregador)	Self Employed (as employer)

Figure 5.44- New table in metadata scope (auxEnum)

After the inclusion of this new table in the main database, part of the sequence of functionality execution has become much simpler and more straightforward.

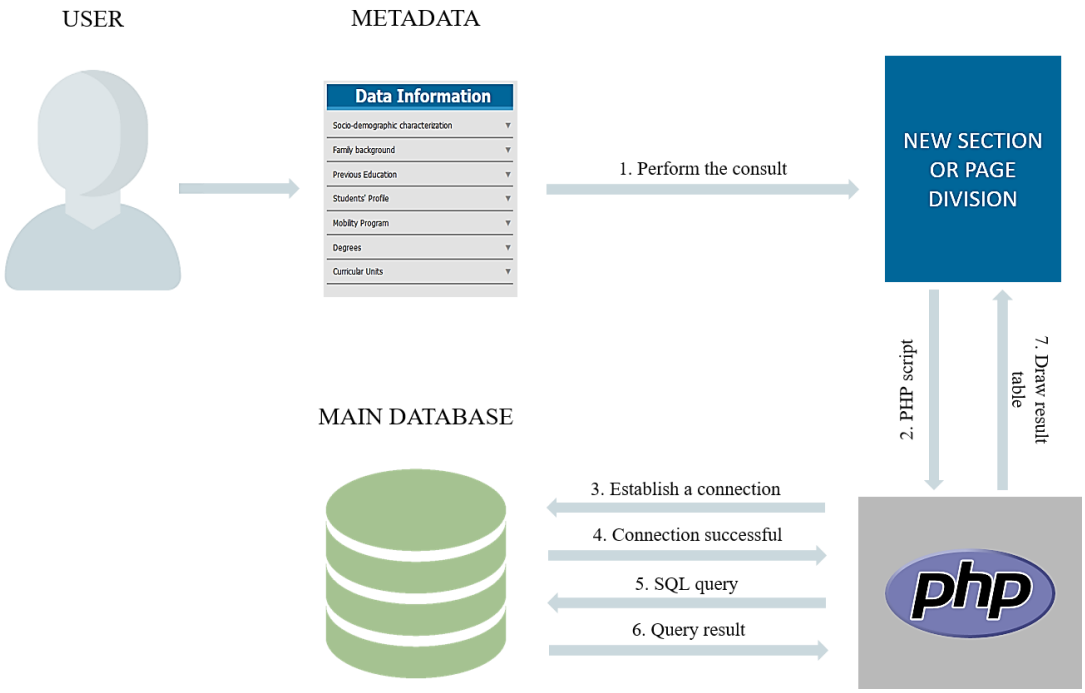


Figure 5.45- Metadata back-end (save button)

5.3.3.4. Latest search

The latest searches feature allows a user to achieve uniqueness and identity in their session. From a usage standpoint, it allows a user to access their saved search history. Not only to see the search name and date, but also to have the option to reproduce the search again.

5.3.3.4.1. Latest search front-end

As for the structure of this tool, it is composed by a table, which contains in each row, information of searches related to the name and date and also the visualization option. Usability is quite simple, user friendly and functional. Again, the tool is closer to the side to make room for a query in the center of the page.

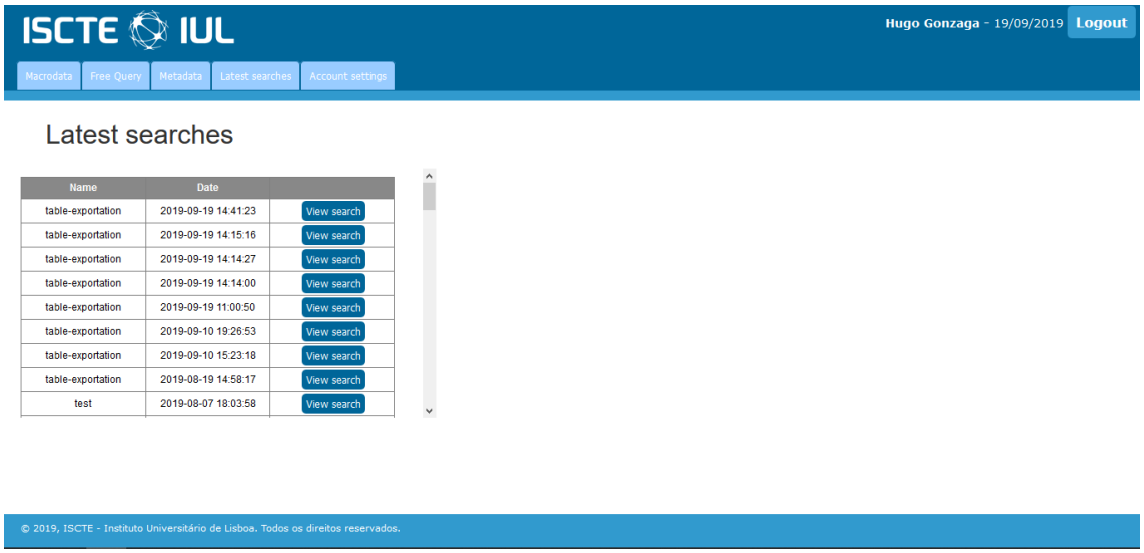


Figure 5.46- UI latest searches

Clicking on "view search" displays a section with the desired search and the export option.

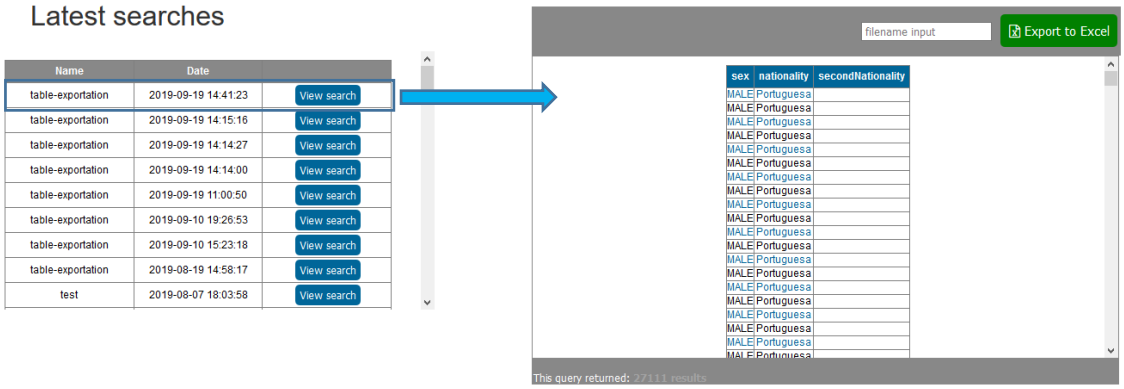


Figure 5.47- UI latest searches example

5.3.3.4.2. Latest search back-end

This tool requires some back-end development. Each time the page loads, a PHP script is executed that connects to the secondary database and executes a query that returns the id, name and date of all user searches. Of all the required attributes, the search id is the only one that comes hidden, the rest are visible in the table.

Associated with each row is a "view search" button. When it is clicked it executes a PHP script which receives the (hidden) search id as input, reconnects with the secondary database, and executes an SQL query by crossing the user id and the search id. Later it receives the result of the query and prints the table.

The following figures illustrate these respective process sequences. Being the first referring to page loading and the second respectively to the process of redisplaying the search.

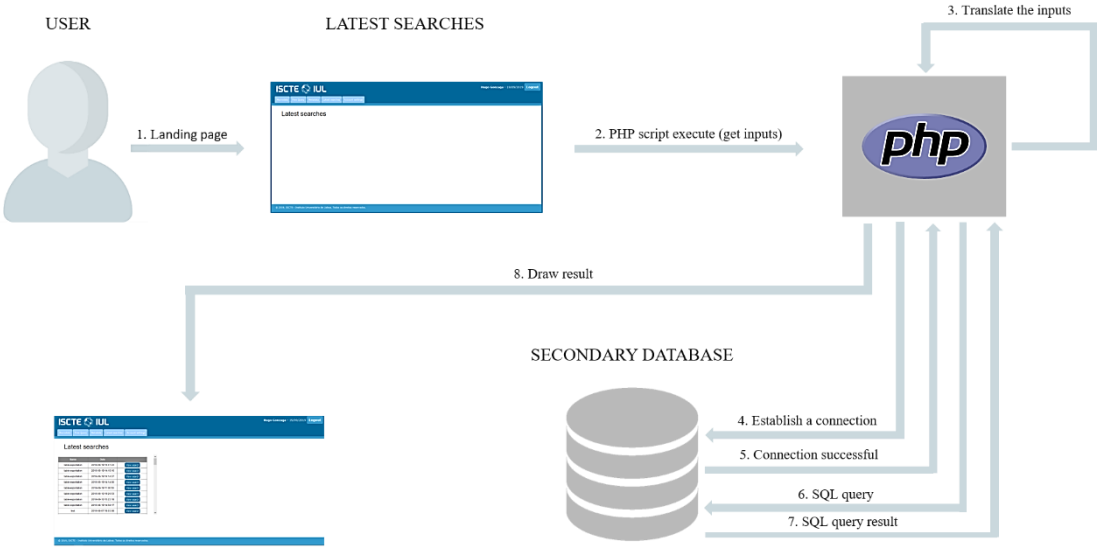


Figure 5.48- Latest searches back-end (landing)

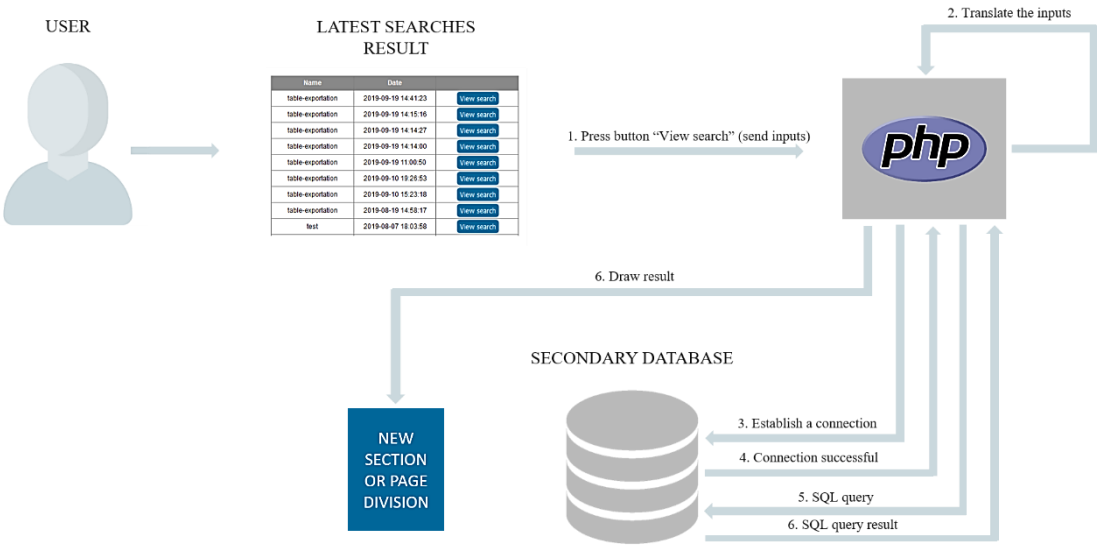


Figure 5.49- Latest searches back-end (view search button)

5.3.3.5. Account settings

The purpose of this page is to provide user information. Specifically, personal data regarding the name, login username and number of saved searches. It also gives the user the option to change the password.

5.3.3.5.1. Account settings front-end

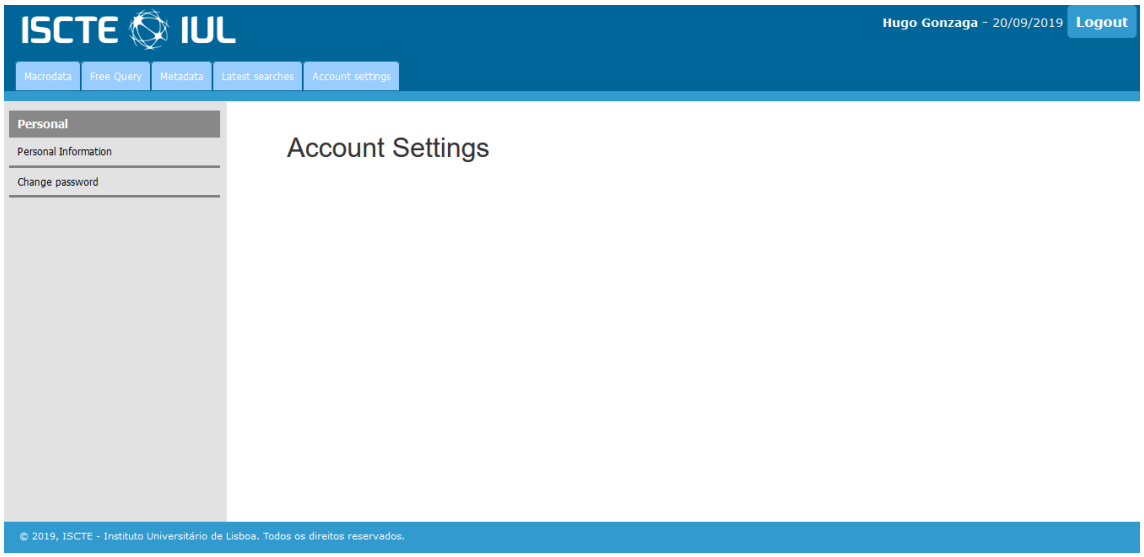


Figure 5.50- UI account settings

In terms of page structure, it offers, like the other pages, a menu with vertical navigation. The difference lies in its composition. It only has two components, the first one referring to personal information and the second one referring to the change of password.

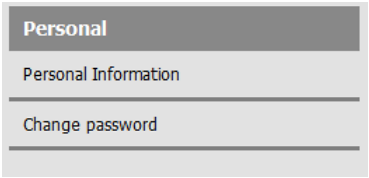


Figure 5.51- UI account settings menu

When the user clicks on "Personal Information" the structure that appears is matched with the following example illustration.

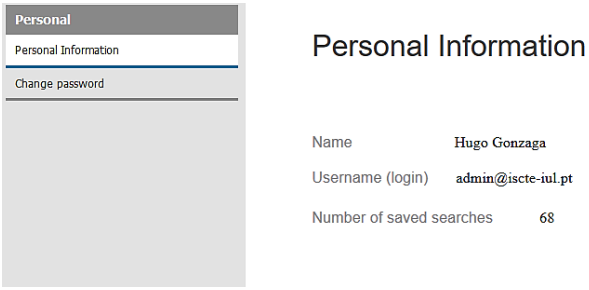


Figure 5.52- UI account settings (personal information)

For the remainder of the menu, when accessed, it displays to the user a password change form.

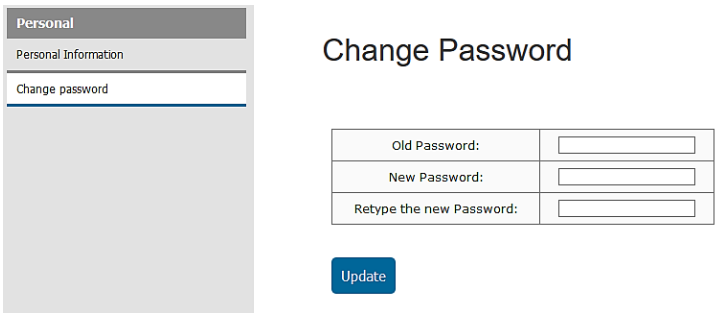


Figure 5.53- UI account settings (change password)

5.3.3.5.2. Account settings back-end

Both components of account setting include back-end development. Each time a user targets the "personal information" component, the loading page executes a PHP script that establishes a connection to the secondary database, generates and executes an SQL command, and finally prints the results related to it. name, login username and number of saved searches.

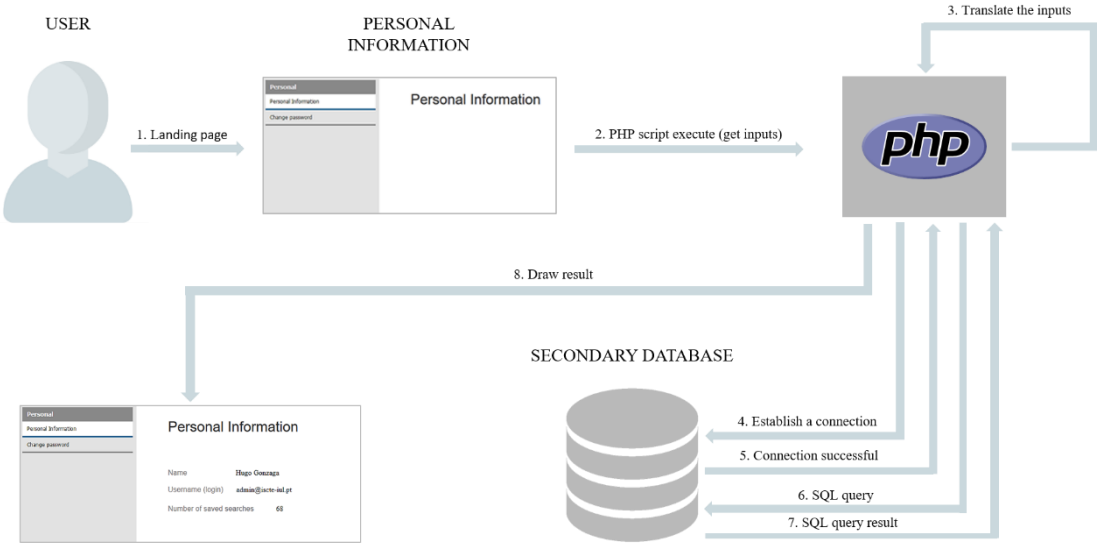


Figure 5.54- Account settings back-end (personal information)

Regarding the second component, namely the "change password", before submitting the form, it is not enough that all fields are filled in, it is also necessary that the two new password inserts be completely matched. As the figure below suggests.

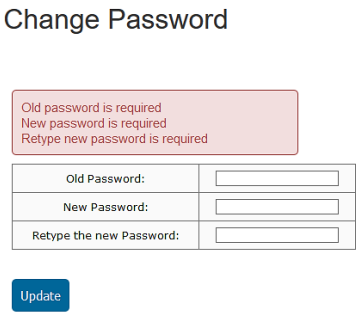


Figure 5.55- Account settings back-end (change password, restrictions)

After submitting the form, it executes a PHP script that connects to the secondary database, executes an SQL query, compares the password in the database with the one filled in as old, and from this moment two possible scenarios might come. In the first, the old password does not match and gives an error message.

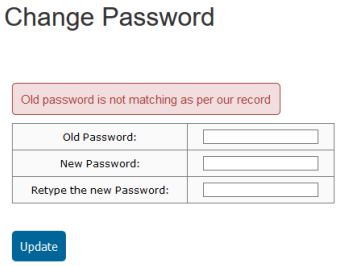


Figure 5.56- Account settings back-end (change password, failure)

And in the second, respectively, the passwords match, the script sends another SQL command with the update value and finally sends a success message.

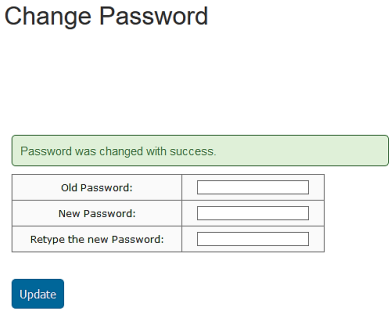


Figure 5.57- Account settings back-end (change password, with success)

The sequence of events on which this development proceeds is shown in the following figure.

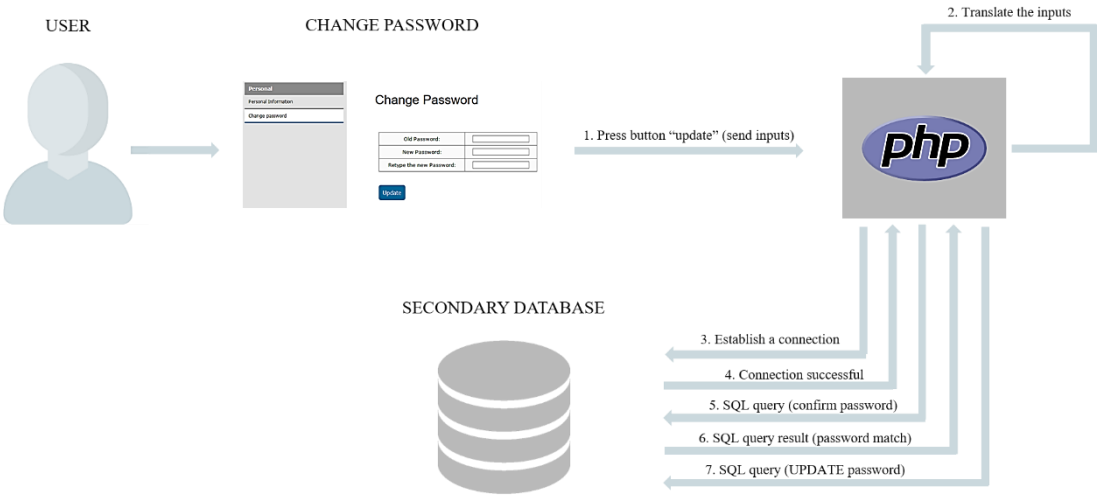


Figure 5.58- Account settings back-end (change password sequence)

5.4. System verification

At this stage, the project is not only tested to verify that it meets user requirements and needs. It is subdivided into three phases: verification, validation and testing. Mainly, to assess whether the system is usable, and to discover any defects in the system.

The system verification process consisted of verifying and confirming that the system essentially met the specification. As such, it included activities such as specification analysis, design analysis, and the testing process itself. In all activities it was found that the product did not escape either the architecture and design for which it was intended to be developed, nor the specifications.

The validation process consisted of confirming that the end product met the user's requirements. The vast majority of variables required in the interviewing process were duly included to allow cross-checking of information in the web application, and the application itself was conceived as one of the requirements in order to support various perspectives and needs. However, it must be pointed out and assumed that it was not yet possible to validate the platform with the interviewees.

The testing process was simply based on direct testing of each of the system's features in isolation, and on overall behavior. Some problems arose as the tests were performed but corrected immediately.

5.5. Evolution and maintenance

The last phase in the development life cycle of this software and is intended to provide support and maintenance for the web application, ensuring that it runs smoothly. As errors, bugs and product defects are found, correcting them is the main objective of this stage in order to improve not only the tool performance but also the user experience.

In addition, as this tool is primarily intended to provide academic data, it should be updated at least once a year. Which implies directly, continue to regularly and periodically manage the databases.

Chapter 6 – Results

The result of this dissertation was a functional web application with a feature set. It is a finished product, which has a basic structure composed of components that are easy to learn and interact and fully functional. However, it only runs on a local server, essentially for security reasons. It contains too sensitive information and in order to make a leap to a remote server it is necessary to double the security requirements, perform twice the tests and ensure a more professional maintenance.

Although planned, it was not yet possible to validate the web application with the interviewed users, as pointed out in the system verification section. However, the implemented tool is being intensively used by three ISCTE-IUL researchers. Two of them are conducting master's dissertations in the context of the analysis of the school career and the other researcher is part of an ISCTE-IUL team in charge of monitoring school success.

The expected information query results were achieved, as well as all other requirements outlined. The implemented system allows to cross many variables considered relevant for studies of academic success, being able to establish and to perform an extremely important function with regard to the aid of this type of studies and investigations.

This web application provides a semantic contextualization of all variables and results of all information that can be crossed. Allowing those interested in the information to understand all possible outcomes, as well as the theoretical framework of the variables.

It also offers a set of predefined indicators based on the existing information consultation system sets related to education indicators, specifically higher education.

All the architecture stipulated in the development lifecycle has been met, which means that the databases have also been properly implemented and are functional to the system. It is also thanks to the fact that the databases are properly adjusted that all the correct functioning of the system is possible, from the login process to any other tool with which the user has contact within the session.

Throughout the implementation phase, all graphical interface illustrations were displayed. So, re-presenting them would be quite redundant. Thus, the following images refer to the process of a sample consultation performed through free query tool of the platform, which is considered as the main tool of this system. In order to focus mainly on the potential for consultation and research aid of this web application. The process begins with the selection panel.

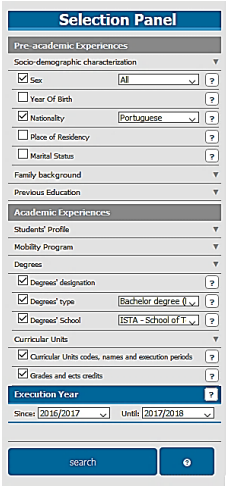
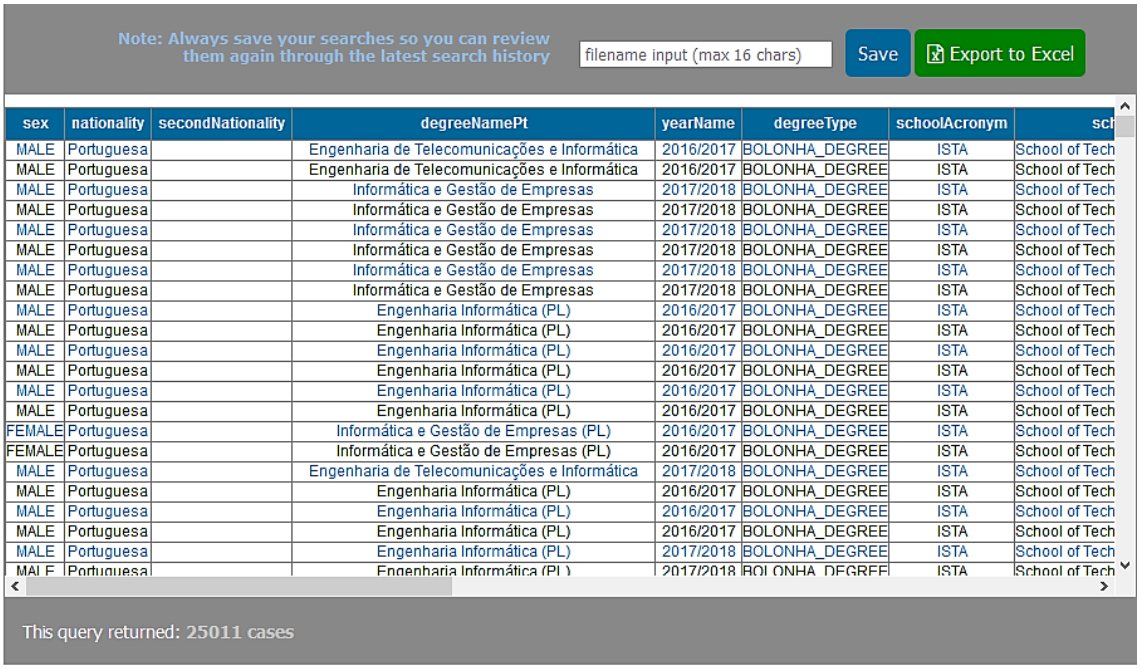


Figure 6.1- Example search - selection panel

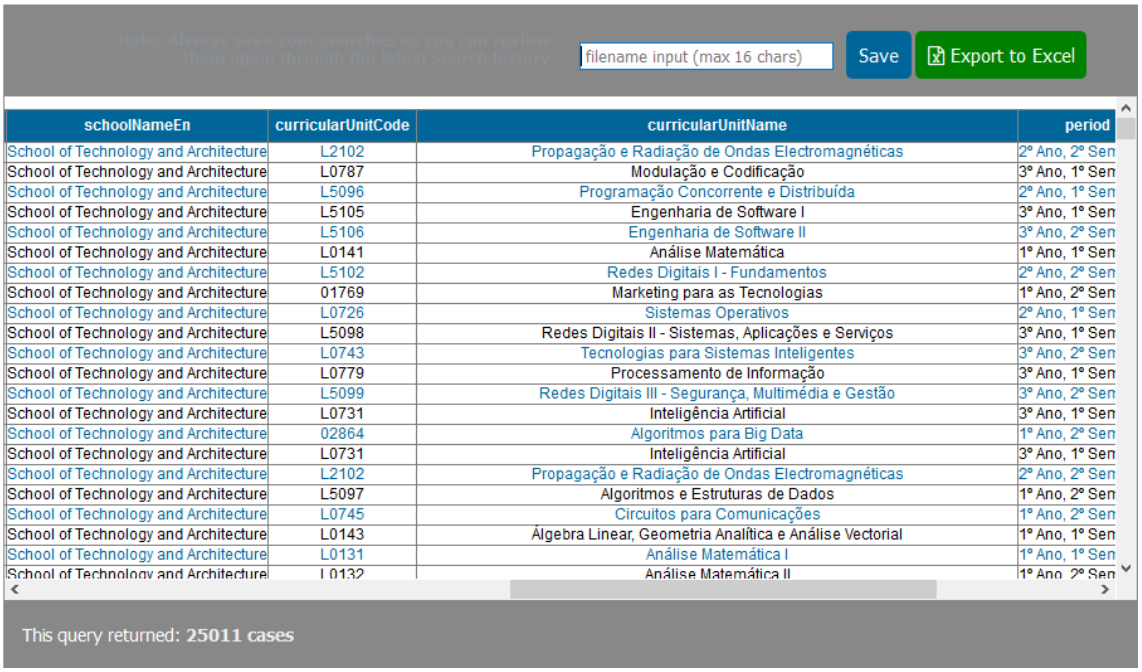
After selecting all the variables to be crossed, perform the search and wait while the results are generated.



sex	nationality	secondNationality	degreeNamePt	yearName	degreeType	schoolAcronym	sch
MALE	Portuguesa		Engenharia de Telecomunicações e Informática	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia de Telecomunicações e Informática	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Informática e Gestão de Empresas	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Informática e Gestão de Empresas	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Informática e Gestão de Empresas	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Informática e Gestão de Empresas	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Informática e Gestão de Empresas	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Informática e Gestão de Empresas	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
FEMALE	Portuguesa		Informática e Gestão de Empresas (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
FEMALE	Portuguesa		Informática e Gestão de Empresas (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia de Telecomunicações e Informática	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2016/2017	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech
MALE	Portuguesa		Engenharia Informática (PL)	2017/2018	BOLONHA_DEGREE	ISTA	School of Tech

This query returned: 25011 cases

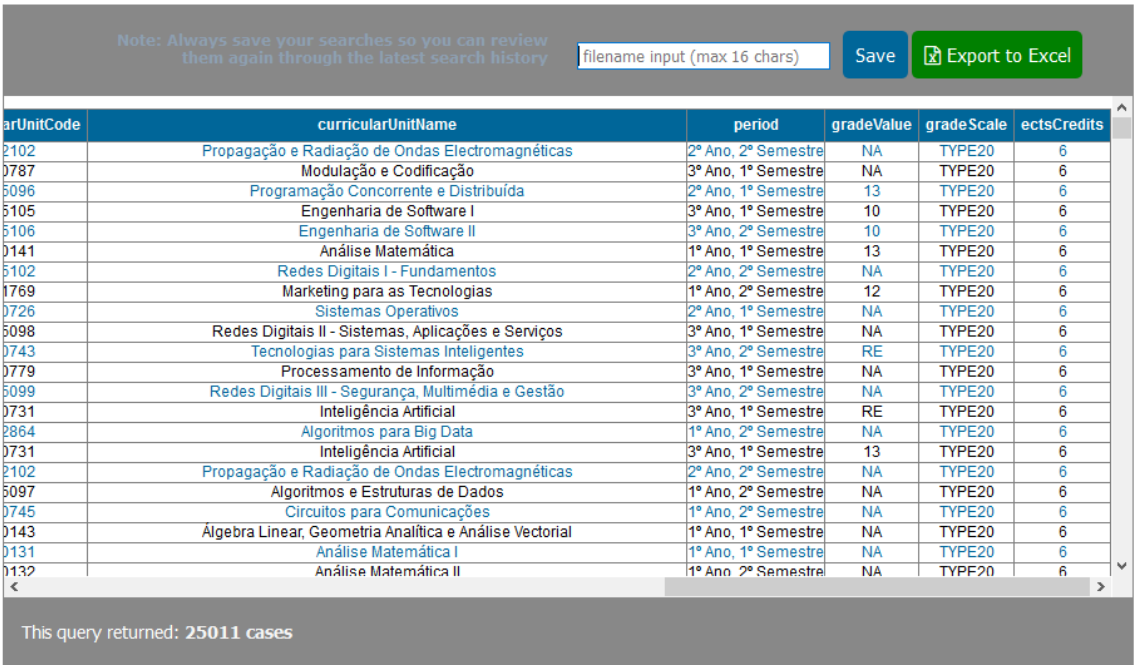
Figure 6.2- Example search - result 1/3



schoolNameEn	curricularUnitCode	curricularUnitName	period
School of Technology and Architecture	L2102	Propagação e Radiação de Ondas Electromagnéticas	2º Ano, 2º Sen
School of Technology and Architecture	L0787	Modulação e Codificação	3º Ano, 1º Sen
School of Technology and Architecture	L5096	Programação Concorrente e Distribuída	2º Ano, 1º Sen
School of Technology and Architecture	L5105	Engenharia de Software I	3º Ano, 1º Sen
School of Technology and Architecture	L5106	Engenharia de Software II	3º Ano, 2º Sen
School of Technology and Architecture	L0141	Análise Matemática	1º Ano, 1º Sen
School of Technology and Architecture	L5102	Redes Digitais I - Fundamentos	2º Ano, 2º Sen
School of Technology and Architecture	01769	Marketing para as Tecnologias	1º Ano, 2º Sen
School of Technology and Architecture	L0726	Sistemas Operativos	2º Ano, 1º Sen
School of Technology and Architecture	L5098	Redes Digitais II - Sistemas, Aplicações e Serviços	3º Ano, 1º Sen
School of Technology and Architecture	L0743	Tecnologias para Sistemas Inteligentes	3º Ano, 2º Sen
School of Technology and Architecture	L0779	Processamento de Informação	3º Ano, 1º Sen
School of Technology and Architecture	L5099	Redes Digitais III - Segurança, Multimédia e Gestão	3º Ano, 2º Sen
School of Technology and Architecture	L0731	Inteligência Artificial	3º Ano, 1º Sen
School of Technology and Architecture	02864	Algoritmos para Big Data	1º Ano, 2º Sen
School of Technology and Architecture	L0731	Inteligência Artificial	3º Ano, 1º Sen
School of Technology and Architecture	L2102	Propagação e Radiação de Ondas Electromagnéticas	2º Ano, 2º Sen
School of Technology and Architecture	L5097	Algoritmos e Estruturas de Dados	1º Ano, 2º Sen
School of Technology and Architecture	L0745	Circuitos para Comunicações	1º Ano, 2º Sen
School of Technology and Architecture	L0143	Álgebra Linear, Geometria Analítica e Análise Vectorial	1º Ano, 1º Sen
School of Technology and Architecture	L0131	Análise Matemática I	1º Ano, 1º Sen
School of Technology and Architecture	L0132	Análise Matemática II	1º Ano, 2º Sen

This query returned: 25011 cases

Figure 6.3- Example search - result 2/3



arUnitCode	curricularUnitName	period	gradeValue	gradeScale	ectsCredits
2102	Propagação e Radiação de Ondas Electromagnéticas	2º Ano, 2º Semestre	NA	TYPE20	6
0787	Modulação e Codificação	3º Ano, 1º Semestre	NA	TYPE20	6
5096	Programação Concorrente e Distribuída	2º Ano, 1º Semestre	13	TYPE20	6
5105	Engenharia de Software I	3º Ano, 1º Semestre	10	TYPE20	6
5106	Engenharia de Software II	3º Ano, 2º Semestre	10	TYPE20	6
0141	Análise Matemática	1º Ano, 1º Semestre	13	TYPE20	6
5102	Redes Digitais I - Fundamentos	2º Ano, 2º Semestre	NA	TYPE20	6
1769	Marketing para as Tecnologias	1º Ano, 2º Semestre	12	TYPE20	6
0726	Sistemas Operativos	2º Ano, 1º Semestre	NA	TYPE20	6
5098	Redes Digitais II - Sistemas, Aplicações e Serviços	3º Ano, 1º Semestre	NA	TYPE20	6
0743	Tecnologias para Sistemas Inteligentes	3º Ano, 2º Semestre	RE	TYPE20	6
0779	Processamento de Informação	3º Ano, 1º Semestre	NA	TYPE20	6
5099	Redes Digitais III - Segurança, Multimédia e Gestão	3º Ano, 2º Semestre	NA	TYPE20	6
0731	Inteligência Artificial	3º Ano, 1º Semestre	RE	TYPE20	6
2864	Algoritmos para Big Data	1º Ano, 2º Semestre	NA	TYPE20	6
0731	Inteligência Artificial	3º Ano, 1º Semestre	13	TYPE20	6
2102	Propagação e Radiação de Ondas Electromagnéticas	2º Ano, 2º Semestre	NA	TYPE20	6
5097	Algoritmos e Estruturas de Dados	1º Ano, 2º Semestre	NA	TYPE20	6
0745	Circuitos para Comunicações	1º Ano, 2º Semestre	NA	TYPE20	6
0143	Álgebra Linear, Geometria Analítica e Análise Vectorial	1º Ano, 1º Semestre	NA	TYPE20	6
0131	Análise Matemática I	1º Ano, 1º Semestre	NA	TYPE20	6
0132	Análise Matemática II	1º Ano, 2º Semestre	NA	TYPE20	6

Figure 6.4- Example search - result 3/3

Afterwards, instead of saving the search, contrary to the examples above, the data is exported to achieve better filtering and analysis.

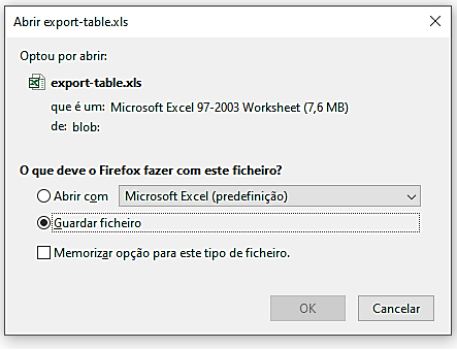


Figure 6.5- Example search - export table

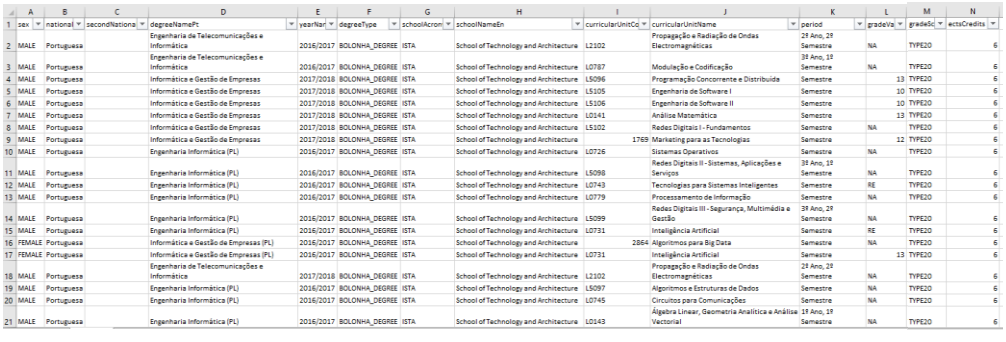


Figure 6.6- Example search - export table result (in excel)

Chapter 7 – Conclusions, Limitations and Future Work

7.1. Conclusions

The contribution of this dissertation was to provide a tool aligned with the scientific contributions to the concept of academic success, as well as the implementation of a system capable of automatic generation of SQL queries based on high level constraints.

This master dissertation presents a system that allows the availability of academic data for interactive consultation. Aiming above all to frame the scope of consultations within the ambit of academic success. In order to enable interested parties to analyze and identify some types of academic achievement standards within the ISCTE-IUL institution.

The institution preserves a lot of student information. By leveraging this aggregate of data to allow for specific misconduct and problems within the institution, it may be possible to establish more effective measures to combat failure in more specific cases. Thus, this web application was developed, which represents a set of research aid features. Offering a user interface through the browser allows direct access for authorized users to a set of information imported from the Fénix system, which was considered as important for the scope of investigations and studies. In addition to the visualization it offers, and in order to allow a much deeper and advanced use, the system grants the exportation of queries to ".xls" compatible software, such as excel.

Through the completion of this dissertation it was possible to gain a broader notion about academic success and conclude that this is a matter of enormous relevance and concern not only for educational policy makers and governments, but also for institutional leaders, practitioners and researchers.

The whole objective of the project proposal has been achieved and it is hoped that this web application can play a very important role as a research aid tool related to academic success. However, new challenges were identified, as well as some limitations, which will be exposed in the following sections.

7.2. Limitations

Throughout the project, some limitations were identified not only at the level of the implemented system.

The first to list is because the Fénix system was not designed or implemented to focus on a 100% tool devoted to studies and research of academic success. And that in itself implicitly means that much of the information contained therein is in no way shaped to be harnessed in the context of such systems. Which leads to the formulation of the second and third limitations encountered.

Many of these fields and variables in the Fénix database were not designed for further analysis, which means that some of them are not required or mandatory. Consequently, when crossing information, there is a great loss of data, which greatly harms those who want to work the full sample of the institution and not just some segments.

Some of the fields in the Fénix database are poorly filled and not standardized. There are anomalies and inconsistencies that limit not so much the availability of information, but above all the further analysis.

One of the main limitations of this dissertation is related to the fact that it was not possible to validate the platform with the interviewees after the implementation process.

Moreover, the last limitation found is directly related to data protection policies. These partly limit the maximum benefit users can derive from microdata. Because, by having to ensure that all identification numbers, including student numbers, are completely excluded from the system, it is impossible, for example, to track a specific student path through the years at ISCTE-IUL.

7.3. Future Work

As mentioned earlier, studies concerned with finding hypotheses to produce contexts that foster student success are increasingly important topics, especially for countries interested in and committed to improving the efficiency of higher education institutions (York et al., 2015; Kuh et al., 2006; Kolster & Kaiser, 2015). And with this as a line of reasoning and guidance, it is necessary to continue the work, and if possible, improve it.

The system should continue to receive Fénix imports each year to further expand the sample of cases and to reveal more and more details of success developments. The system must also continue to be used and tested so that more errors and failures can be modified and improved.

There must be a continuation and further deepening in the investigation. More indicators could be established, probably this dissertation does not focus on all indicators of academic success to which the Fénix could even respond.

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Appendix A – Fénix system in ISCTE-IUL

Currently at many universities, the use of web technology has become a vital part of the academic administration (Lotsari et al., 2014; Piety et al., 2014). As mentioned in previous chapters, the Fénix is an example of how increasingly information systems and web technologies are important to the educational systems, and also how these systems have a major positive impact on the use and services' simplification.

System description and functionalities

As described on the Fénix login page, from an overview, this system provides ISCTE-IUL certified users (students, teachers, employees and candidates) with a diversity of services and features, to simplify the daily life of all those who study or work at this institution (Fénix ISCTE-IUL, n.d.). Features on the platform may differ depending on the types of users.

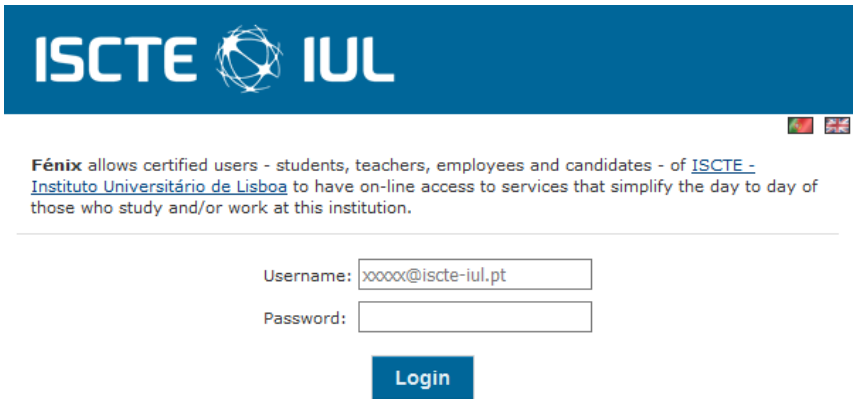

Figure- Fénix - Login Page

Some of the features

Throughout this chapter, functionalities of some of the main roles performed in the institution are described. It is therefore necessary to point out that there are many more Fénix features performed by other entities not less important to the institution, however, for the purposes of demonstrating the impact of Fénix on academic daily life, only a few were used.

From the perspective of the student-user, there are features such as: students' curriculum, students' attendance to curricular units, students' semester schedule, register in intermediate assessments, consult grades (intermediates and finals), academic work (projects, dissertations and thesis) management, access to file repository, manage enrollments, submit candidacies, participate in institution's surveys and personal data authorization options, among other functions.

At the level of a teacher-user, the available functions focus on the main activities performed by the teachers, such as the administration of curricular units, appreciation of the curricular unit, launching grades, managing student attendance, assessment

management, consultation. class schedule, guidance management (thesis, academic work), teaching service management, summary management, teaching time consultation and content repository administration.

Observing the non-teaching employee-user access area, the available functions allow the attendance records to be consulted and the self-justifications to be inserted.

In addition to the portals mentioned above, there are also reserved areas for specific institutional positions related to course management as well as department management. Being the functionalities of the first case, respectively: conduct course appraisals, management of academic assignments and learning objectives linked to the course curricular units. And in the second case, correspondingly: submission of teacher lists to be hired for the next semester or school year, consultation of all teachers in the department with active contract in the selected school year, management of curricular units' teaching hours and the hours allocated to teachers.

Although the features described only represent a part of the full range of functions that Fénix supports as mentioned early, it can be seen that this system has a very significant impact on the services that are used over a school year. It is visible that it is a platform that transposes many of the academic services to digital, simplifying above all the storage of processes and data, which previously was usually physical. Over the years, by centralizing many of these services through Fénix-like technologies, it promotes a natural increase in the amount of academic data stored (Lotsari et al., 2014; Piety et al., 2014).

Potential of the data in the system

Beyond all the features available, Fénix has an extensive database where all the information is stored. As such, it has a record of all students who enrolled the ISCTE-IUL university. Being these records, not only made up of personal data, but a vast set of data referring to the entire course of the students in the institution. These large volumes of data might eventually be a priceless asset that can be used as study tools to uncover patterns and draw conclusions (Lotsari et al., 2014).

It should be emphasized that the Fénix is not a platform for the purposes of an academic success analysis tool. Eventually some data may not be worked for this purpose, as some indicators proposed in academic success measurements may not be adapted or fitted in this context. However, it is necessary to focus all interest on data within the framework of academic success, and it is also important to understand the types of data needed from what is available, and exactly how that data should be used in order to allow the establishment of good analyzes, and in turn, decent conclusions (González, 2009).

To this end, the next steps will be to set up a set of interviews to gather the needs of potential users with regard to which data will be of greatest interest to consult and what data should or should not be used in the context of the ISCTE-IUL analysis of success.

Appendix B – Interview Script

ISCTE IUL
Instituto Universitário de Lisboa

Interview Script

Relevant data for academic success studies

This interview is being conducted as part of a research project inserted in the context of the analysis of school success/failure at ISCTE-IUL. The aim is to provide interested teachers and researchers with access to data, so that each one can prepare the analysis that considers most appropriate.

The interview aims to gather the needs of potential users regarding the data for which there will be greater interest in consulting.

I. What is your definition of academic success?

II. What factors are most involved or condition academic success?

III. Which segments of students may be more vulnerable to failure?

IV. Given the universe of the Fénix system, what are the data that seem to be most relevant to establishing indicators of academic success? Or others that with this concept may be related or implied in its explanation?

V. Comment on the possible usefulness of having a platform that allow to consult and download academic data related to academic success.

Thank you very much for your attention and collaboration,

Hugo Gonzaga

Appendix C – User Manual

Departamento de Ciências e Tecnologias da Informação

User Manual

Provision of Academic Data for Research:
A Step for Academic Success

Hugo Gonzaga Parente Miguel

Supervisor:
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ISCTE-IUL

Co-Supervisor:
Doctor Susana da Cruz Martins, Assistant Professor
ISCTE-IUL

September 2019

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Chapter 1 – Web Application

1.1. Access the application

The web appliacation itself does not require any download. However, despite being a web application and being accessible through a compatible browser, such as Mozila Firefox, Microsoft Edge, Google Chrome, the server is currently local for testing purposes. Consequently, to access the application it is necessary to run the local server and the following address must be used: **http://localhost/webApp**.

For this link to be available, software with features identical to XAMPP (which was the one used) is required to offer a cross-platform web server solution package consisting principally of the Apache HTTP server, MariaDB database, and script interpreters written in the PHP.

Using the XAMPP tool, it should be checked if the following directory contains all the web application-related files: **xampp\htdocs\webApp**

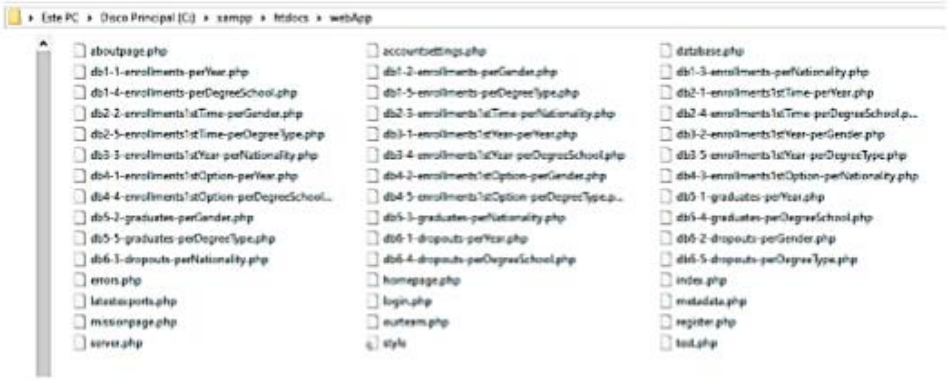

Figure 1- File directory (webApp)

And the database files should be checked in the following directories:

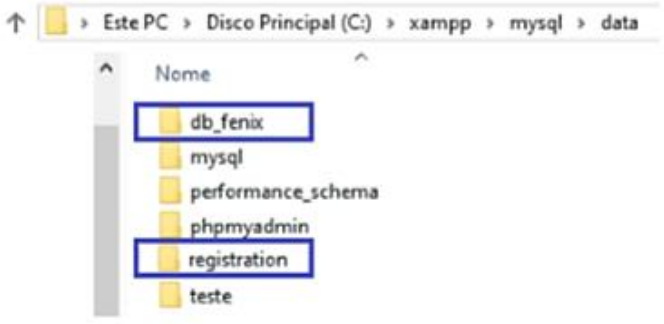

Figure 2- File directory (databases)

1

Finally, the servers must be started, and the link should be available.

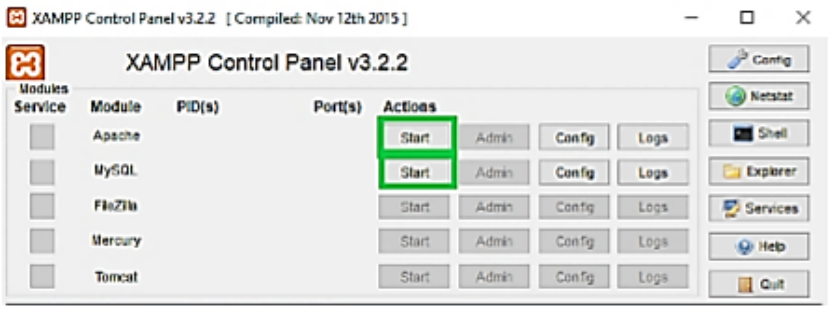

Figure 3- XAMPP control panel (start servers)

1.2. Login

To login, the user must be previously registered in the system by the administrator and submit a valid username and password combination in the form of the "login" page.

Figure 4- Login page form

Successful login implies that the username and password combination is valid. Successful and valid login routes the user interface to a user session, and from the session comes a navigation menu that allows unique functionality for an authorized user, such as: macrodata, free query, metadata, latest searches and account settings.

Figure 5- Web app main navigation menu

2

Figure 6- Web app home page

1.3. Macrodata

In order to access this feature, the user needs to select the "macrodata" option from the main navigation menu.

Figure 7- Web app main menu (Macrodata)

Macrodata is a feature that provides a user with research on a set of predefined indicators in the context of higher education and academic success. The following figure illustrates the page structure.

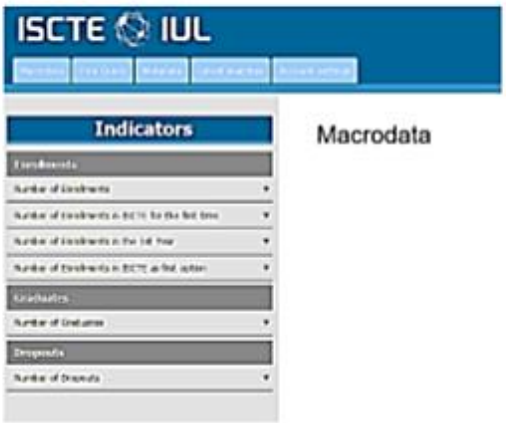

Figure 8- Macrodata page

These indicator sets are included in a side navigation menu within the user can interact by expanding and shrinking components and also choosing what to search for through clicks.

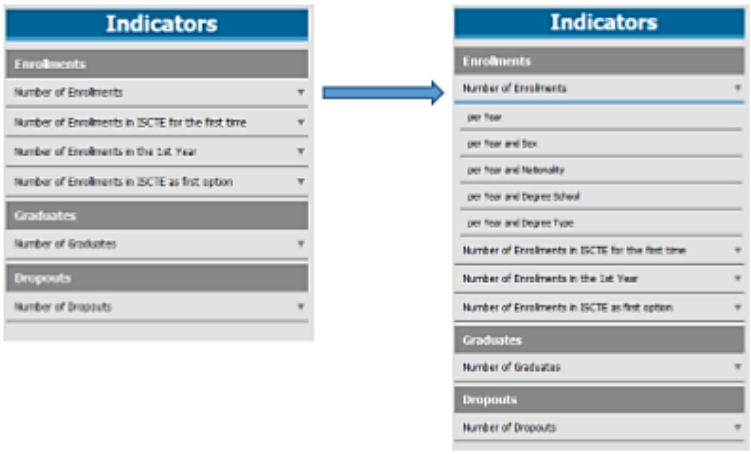

Figure 9- Macrodata page (Indicators menu)

Thus, starting a search simply implies that the user clicks on one of the expanded subgroups.

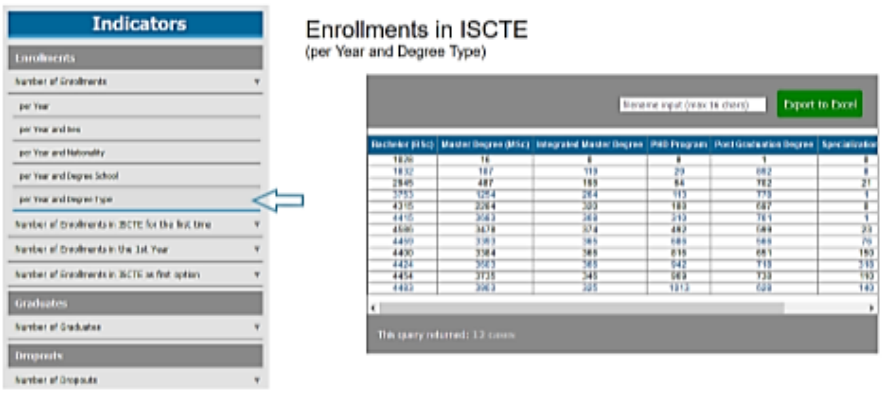

Figure 10- Macrodata page (search example)

Such queries allow the user to export the result to an excel compatible file. To do this, the user just needs to click on the "Export to excel" button and if desired, has the option of naming the exported file.

Note: The name must be entered before executing the export button. Otherwise the file is exported with a default name.

Figure 11- Macrodata page (export function)

1.4. Free query

In order to access this feature, the user needs to select the "Free query" option from the main navigation menu.

Figure 12- Web app main menu (Free query)

This functionality is intended to enable cross-reference of a student data set in the context of finding new patterns and pathways for academic success. The following figure exemplifies the page structure.

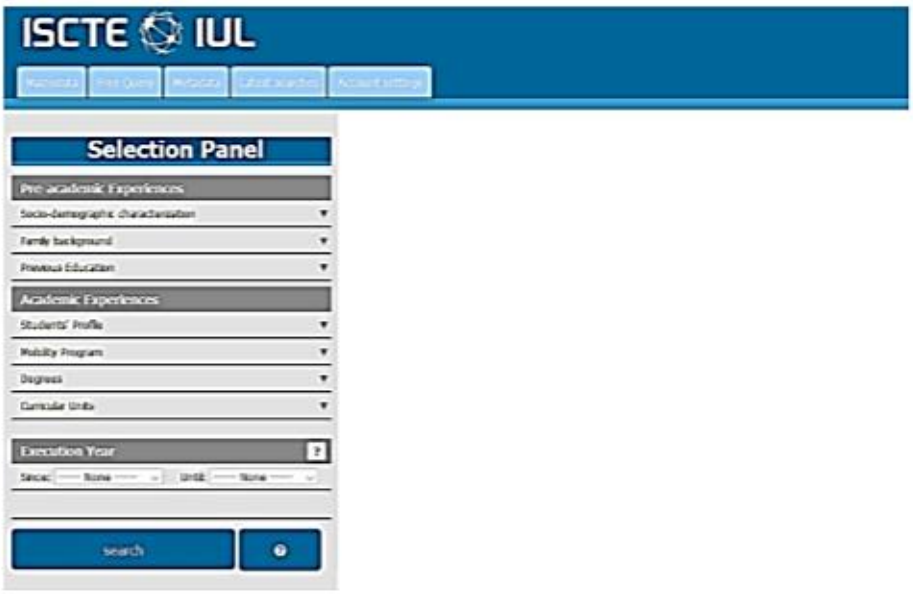

Figure 13- Free query page

This feature has a structure consisting of a selection panel (side navigation menu), in which each title (pre-academic and academic experiences) includes a set of dimensions and in turn each dimension, a data set.

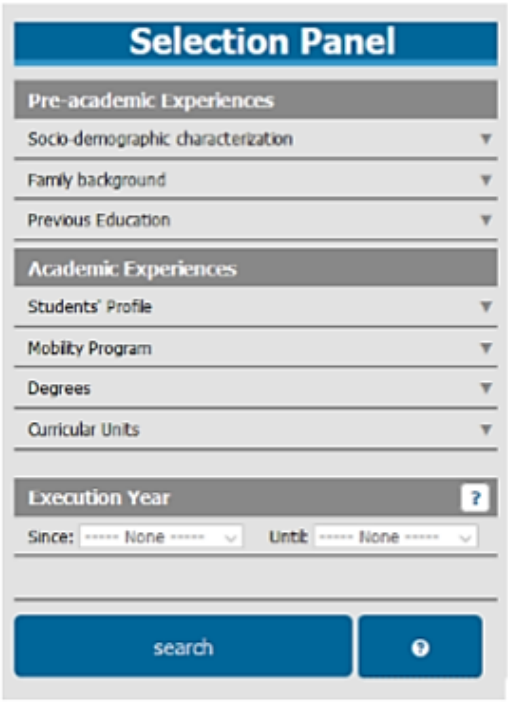

Figure 14- Free query page (Selection panel)

Each dataset of each dimension, by definition, is hidden but expandable. This means that the user to access each variable has to expand its dimensions by clicking.

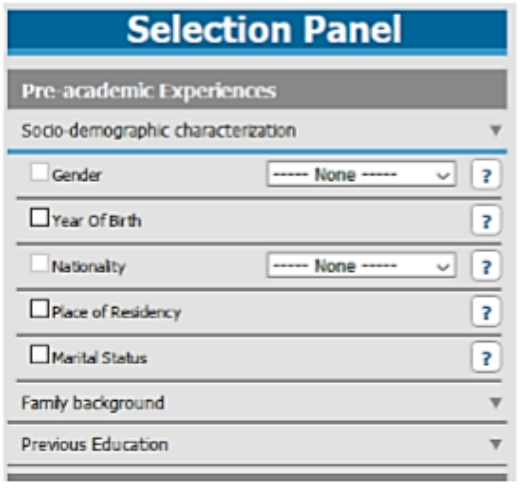

Figure 15- Free query page (Selection panel datasets)

6

To define which variables to cross, the user must select the check boxes for each variable. As the figure below exemplifies.

Figure 16- Free query page (Checkboxes)

The user in some of the variables has the selection filter option. This selection is made through a list of options that is next to the variable.

Figure 17- Free query page (Variables selection filter)

Since some of the variables may not be so semantically clear to the user, each variable has a brief description inserted in the help hint button. To view the description the user only has to hover the mouse over the button. As the following figure suggests.

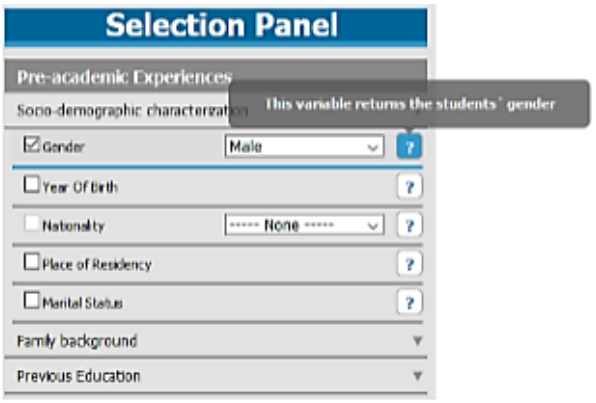

Figure 18- Free query page (Variable help hint button)

To use year filtering, the user first needs to select at least one variable that relates to the years. The list of variables that relate to the year is available in the respective year's help tip, as per the example below.

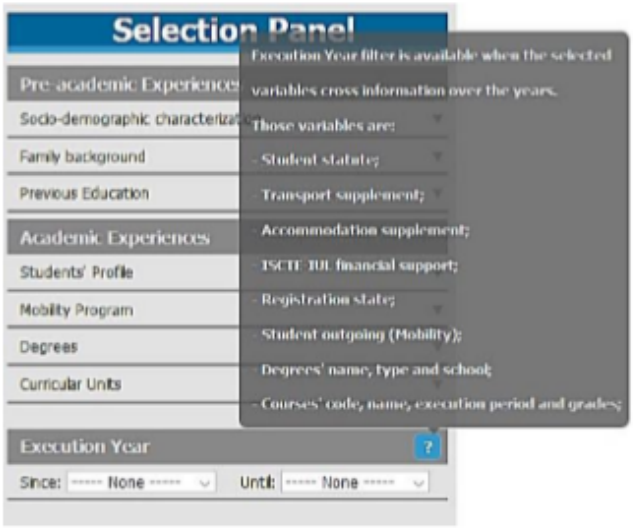

Figure 19- Free query page (Year help hint button)

Once one of these variables is selected, the filtering field of years is automatically unlocked.

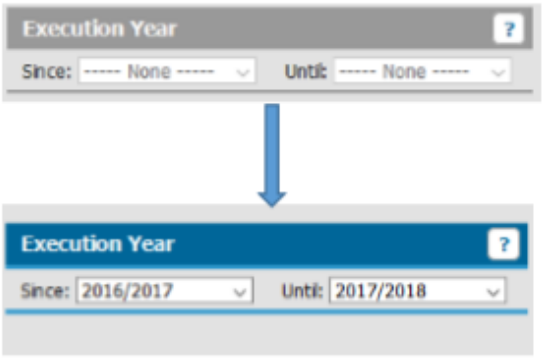

Figure 20- Free query page (unlock year filter)

Finally, in order for the user to see the crossing of the selected variables, just click on the button at the bottom of the menu, called "search".

Note: In order for the search to begin, at least one variable must be selected.

Figure 21- Free query page (search button)

The user will have access to the desired results in the most central area of the page, as exemplified by the following figure.

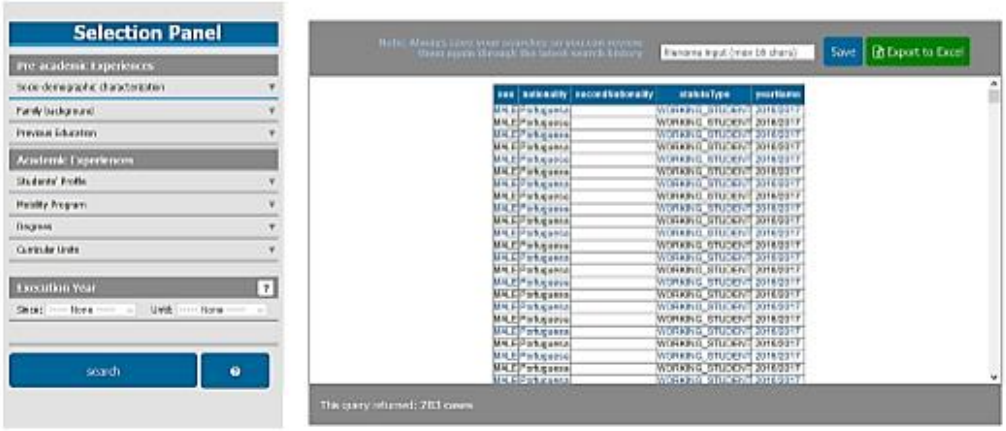

Figure 22- Free query page (search example)

Each search allows the user to export or save a search. Both roles share the option to name the search. To execute each function, the user only has to click respectively on the button that performs the desired function.

Note: The name must be entered before executing either the save or export buttons. Otherwise the file is saved or exported with a default name.

Figure 23- Free query page (export and save function)

The user is advised to save their searches so that they can refer back to them later using the "Latest searches" feature.

Figure 24- Free query page (save function recommendation)

1.5. Metadata

In order to access this feature, the user needs to select the "Metadata" option from the main navigation menu.

Figure 25- Web app main menu (Metadata)

It is a feature that has a contextualisation potential associated with the free query tool, as it provides the user with a description of all the variables present there. The following figure exemplifies the page structure.

Figure 26- Metadata page

The user can interact with this feature through a side navigation menu, by maximizing and minimizing components and also choosing what to search for through clicks.

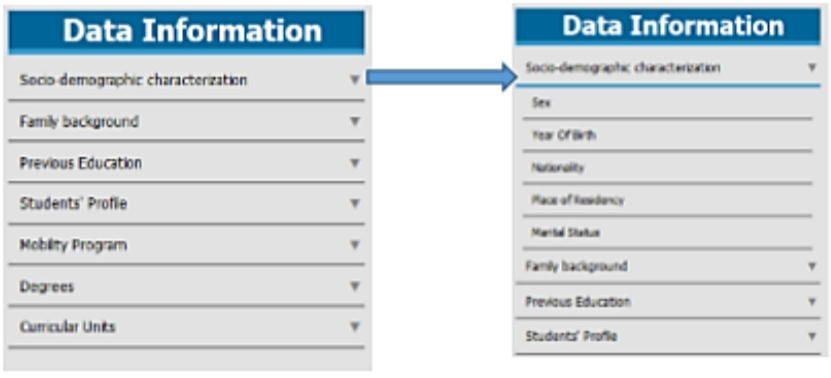

Figure 27- Metadata page (data information menu)

For the user to see a description of some variable, simply click on one of the expanded subgroups for the desired variable, as the figure below exemplifies.

Figure 28- Metadata page (search example)

1.6. Latest searches

In order to access this feature, the user needs to select the "Latest searches" option from the main navigation menu.

Figure 29- Web app main menu (Latest searches)

It allows a user to access their saved search history. The following figure exemplifies the page structure.

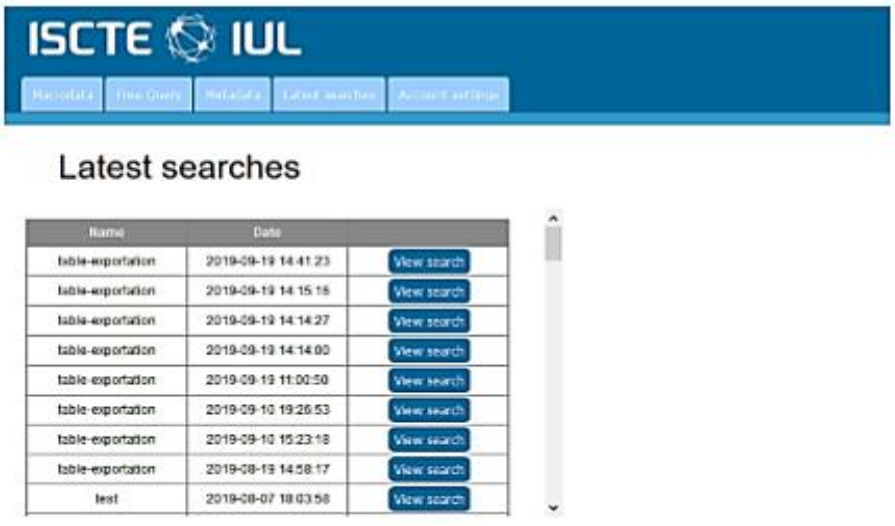

Figure 30- Latest searches page

This functionality allows the user to automatically view the search name and date as soon as it lands on the "latest search" page, but also has the option to replay the search.

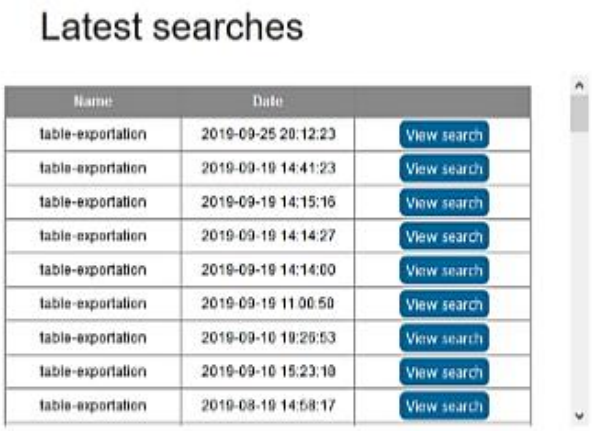

Figure 31- Latest searches page (searches list)

For the user to navigate the searches performed just have to use the scroll bar. To view a search, the user has to click on the "view search" button of the respective search.

Figure 32- Latest searches page (view search button)

The desired search results will be fixed next to the search history list. As illustrated in the following figure.

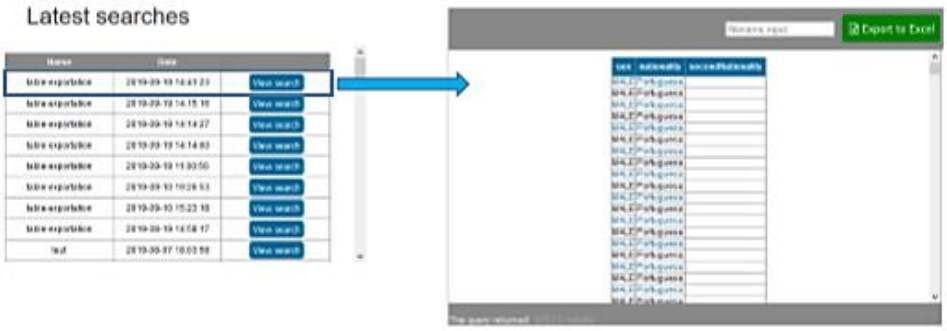

Figure 33- Latest searches page (search example)

After viewing the search, the user also has the export feature with the option to name the search. To execute it just click the "export to excel" button.

Note: The name must be entered before executing the export button. Otherwise the file is exported with a default name.

Figure 34- Latest searches page (export function)

1.7. Account settings

In order to access this feature, the user needs to select the "Account settings" option from the main navigation menu.

Figure 35- Web app main menu (Account settings)

On this page the user can consult account information. The following figure exemplifies the page structure.

Figure 36- Account settings page

The user can interact with this feature through a side navigation menu, choosing what to look for by clicks.

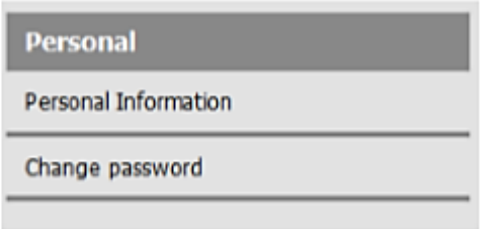

Figure 37- Account settings (Personal menu)

Clicking on the "Personal Information" menu component automatically brings up user related information.

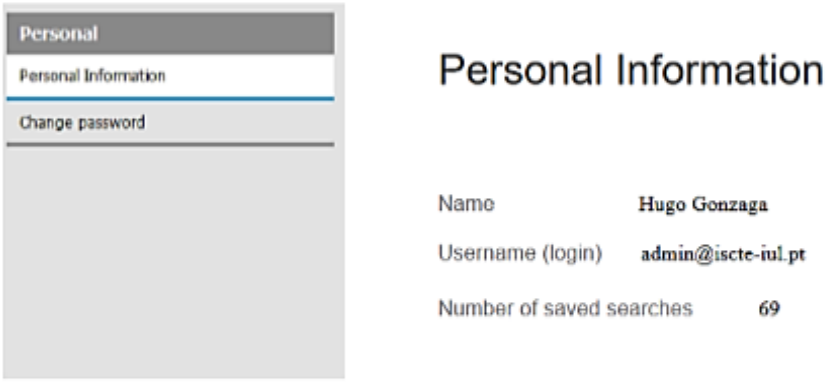

Figure 38- Account settings (Personal information)

Clicking on the "Change password" menu component automatically brings up a password change form.

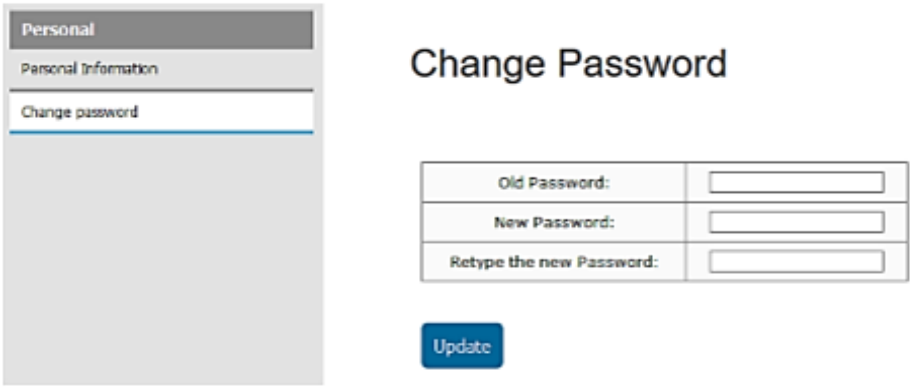

Figure 39- Account settings page (Change password)

For the user to take advantage of the password change form, they must comply with the form completion rules. Such as, all fields are required, and the new password field and second re-entry of the new password must be the same. As illustrated in the figure below.

Figure 40- Account settings page (Change password rules)

To submit the form, you have to click on the "Update" button.

Figure 41- Account settings page (Change password update button)

This feature will only be successful if the user presents the correct old password and the new passwords match. The user knows if the password was successfully changed through a success or error message.

The success message that the user receives has the following structure.

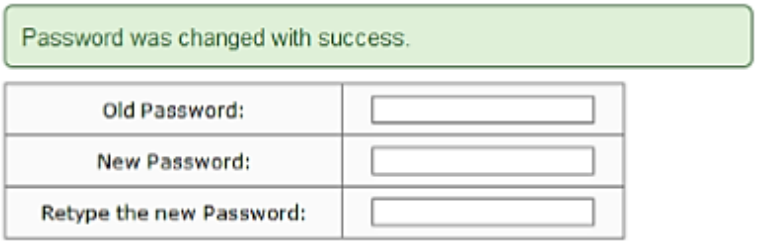

Figure 42- Account settings page (Change password with success)

The error message that the user receives has the following structure.

Figure 43- Account settings page (Change password without success)

1.8. Logout

First, to log out, the user must be previously logged in to the system. Then, to logout, the user must go to the upper right corner of any page of the session and click the "Logout" button.

Figure 44- Logout button on a page

Figure 45- Logout button