AN APPLICATION OF THE STUDENT RELATIONSHIP MANAGEMENT CONCEPT

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Abstract: It is largely accepted that a way to promote the students' success is by implementing processes that allow the students closely monitoring, the evaluation of their success and the approximation to their day-by-day activities. However, the implementation of these processes does not take place in many Higher Education Institutions due to the lack of appropriates institutional practices and an adequate technological infrastructure able to support these practices. In order to overcome these conceptual and technological limitations, this paper presents the *Student Relationship Management System* (*SRM System*). The *SRM System* supports the *SRM concept* and the *SRM practice,* also here presented, and it is implemented using the technological infrastructure that supports the *Business Intelligence* (*BI*) systems. The SRM system was used in an application case (in a real context) to obtain knowledge about the students and their academic behaviour. Such information is fundamental to support the decision-making associated with the *teaching-learning* process. All the obtained results are also presented and analysed in this paper.

1 INTRODUCTION

One of the measures that it is largely accepted as a way to promote the students' success in Portuguese Higher Education context is by implementing mechanisms that allow the students closely monitoring, the evaluation of their success and the approximation to their day-by-day academic activities (Pereira, Motta and Vaz, 2006). Several actions have been undertaken in order to improve the success of the day-by-day academic activities, like for example, tutoring programs (Pile and Gonçalves, 2007). However, some of the tasks involved are not compatible with the work overload of the teaching staff, the large number of students in academic years with high failure rates and the lack of institutional practices and technological support to monitor the students' academic activities. In order to overcome these conceptual and technological limitations, it was proposed a system designated by *SRM System - Student Relationship Management System*. The system supports the *SRM concept* and the *SRM practice* that are defined in this paper. Underlying to the *SRM concept* is the success promotion, through the establishment of a close relationship between the *institution* and the *student*. The objective is the continuous monitoring of the students' academic activities, allowing the identification and anticipation of problematic academic situations related with the students' failure. Knowing such situations, adequate actions/decisions can be taken to handle them, supporting an adequate and effective *institution-student* relationship.

This paper is organized as follow: Section 1 presents the motivation for this work, justifying the *SRM system* proposal. Section 2 includes an overview about the principles behind the proposed *SRM concept* and *practice* and the adopted methodology to validate these concepts. Section 3 describes the structural options, which supports the *SRM system* architecture proposal and the issues related with the *SRM system* implementation. Section 4 presents an application case and the results

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obtained through data analysis using OLAP and data mining tools. Section 5 includes some remarks about the *SRM system* advantages and the work already undertaken. Future work is also addressed in this section.

2 CONCEPTUAL FRAMEWORK

The *SRM System* was inspired in the principles underlying the *CRM - Customer Relationship Management* Systems*,* which are used in business environments to support, develop, maintain and manage relationships between organizations and their customers. These systems help to translate *customer information* into *customer knowledge*. The *customer knowledge* is obtained from all the information and business transactions between the organization and customers. Supported on this *customer knowledge*, the organization defines and implements the activities and organizational practices that allow developing and maintaining an adequate relationship with customers. Values like reliance, fidelity, loyalty and durability must be present, developed and maintained in this practice. The quality of the relationships is a key factor, since it should result into a competitive advantage of the organization over its customers, and must also result in a value for its customers.

2.1 CRM vs. SRM

The *CRM Systems* main functionalities allow to automate, to support and to manage processes and activities dedicated to the customers, as marketing activities (customer prospects, customer segmentation, planning and managing marketing campaigns and contacts management); sales activities (automatic sales management, sales support services, orders management, and analytical sales) and services (call-centers management, help-desks management, product configuration), among many others (Payne, 2006). There are also technological solutions designated by "*CRM Systems in Higher Education*". In such cases, the "*customer*" is understood as the "*student*" (prospective, current and alumni), as an *"institution member"* (teachers and administrative staff) and as an "*external institution member*" (parents, suppliers, organizations and other higher education institutions). Each one of these "*customers*" could interact with one or more different functional areas. These solutions are mainly dedicated to support, automate and manage processes related with the "*current students"* in the academic area (students' management information, courses and lessons management, admissions management, enrolment and registration management) and other areas related with the available services (communications, marketing, financial aids, accommodation). A close attention is also dedicated to the "*prospective"* and to the "*alumni"* students, through personalized communications, directed advertising or marketing activities, which main role is to attract prospective students and to improve the amount of donations from alumni and other donors (the refereed above is not applied in many higher education contexts) or to advertise new courses, like pos-graduate courses, to turn back these students to the institution. For an "*institution member"* these technological solutions allows to optimize and to facilitate the internal interactions and communications, the access to the several available services, including the access to fundamental information, related with the students or other administrative services. For an "*external institution member"* allows to enhance and to automate the interactions with the institution using different contact channels (personnel, phone, email, mobile, web) (Grant and Anderson, 2002), (Fayerman, 2002). The different technological solutions available in market are aligned with the practices enforced in a higher education context and with the reality of each institution in particular.

The "*Student Relationship Management*" designation was already used in higher education contexts, but only with a technological/commercial role. The main difference, looking at the "*CRM Systems in Higher Education"*, is related with the designation of *customer*, representing the *student*, but the supported activities and the underlying principles are similar.

2.2 SRM Concepts

This paper presents a new definition of the *Student Relationship Management* concept and the related technological support. This definition is focused on the closely monitoring of the students' academic activities, with the main purpose to promote the students' academic success. To be possible, the institution needs to define a *SRM strategy* and a SRM *initiative*. The *SRM concept*, the *SRM practice*, the *SRM system*, the *SRM strategy* and the *SRM initiative* are thus fundamental and now described. The *SRM concept* is a process based on the students' acquired knowledge, whose main purpose is to keep an effective *students-institution* relationship through the closely monitoring of the students' academic

activities, having in mind that there exists a strong correlation between the closely monitoring of the student's activities and his/her scholar success promotion. The *SRM practice* is a set of activities, defined by the institution, which should guarantee a customized contact with the students and an effective, adequate and closely monitoring of their academic performance. The *SRM system* is the technological infrastructure that supports the *SRM concept* and that makes possible the implementation of the *SRM strategy* and *practice* in the institution. The *SRM strategy* is the strategy defined by the institution, to set up the main activities associated by the *SRM concept* and *practice*. The strategy must be aligned with the institution vision, mission and aims, and must also commit with it all the involved actors (teachers, students, directors, among others). The strategy must include the activities to be developed in this scope, as well the several participants and related actions. To take a *SRM initiative*, the institution should define: (i) A *SRM strategy* that commits the institution with the *SRM practice*; (ii) The set of activities that are included in the *SRM practice*, and the specific actions that must be carried out by the several participants of this practice. The *SRM practice* includes, for example: the identification of the performance indicators and the behaviour patterns that characterize the different situations that will be supervised; the students' monitoring process definition and the related activities and actions to be executed by each participant; (iii) The implementation of the *SRM practice* in the institution, adequately supported by the *SRM system;* (iv) The validation of the *SRM practice*, using the obtained results, and, if necessary, the redefinition of the practice.

2.3 Concepts Validation Methodology

The proposal of the concepts was based in a first phase on the experience of the authors of this paper and, on a second phase, in a research study. In the last one, it was followed an interpretative research methodology, which recognizes the subjective importance of the observations, and also the subjectivity associated with the events narrative and related results (Myers, 2007). To validate the proposed concept and related practice it was adopted a methodology which included the realization of a set of interviews. The objective was to involve other participants in the concept definition and in the identification of the several activities included in the SRM practice (the concept and the activities were previously defined by the authors of this paper, but the interviews allowed their validation and complementation). The interviews were guided by a script, prepared beforehand, but including open question (semi-structured interview). The selected interviewers, and in order to complement the initial definitions, were teachers with institutional responsibilities (courses' directors, institutions' directors/presidents, council' members). Each interview was recorded and later transcribed. The interviews analysis process was done following the *Grounded Theory* principles (Hansen and Kautz, 2005) and was supported by a *Computer Assisted Qualitative Data Analysis Software* (Budding and Cools, 2007), concretely the *NVivo* software. The interview questions included topics like: academic success/failure, activities to promote the academic success; *student-institution* relationship; practices to maintain an effective *student-institution* relationship; monitoring and supervising processes (also including participants and related activities); indicators and behaviour patterns; main activities that can be supported by a technological platform. The interviews analyses supported the definition of the *SRM concept*, the set of activities that integrates the *SRM practice* and the *SRM System* main functionalities (Piedade and Santos, 2008).

3 SRM SYSTEM

As it was previously mentioned, nowadays there no exists an adequate technological support to the *SRM concept* and *practice*, like they are understood and conceptually defined in this paper. Besides the conceptual formulation, this paper also proposes the technological infrastructure, the *SRM System* that supports the *SRM concept* and makes possible the *SRM practice* implementation.

3.1 Structural Framework

To implement the *SRM practice* it is crucial to have appropriate, consistent and complete information about the students. From an effectively information analysis must result *knowledge* about the students and their academic behaviour. Based on this *knowledge* a set of *actions* over the student or the students (previously defined in the *SRM practice*) should be executed. For the implementation of the activities included in the *SRM practice*, it is necessary: (i) That the information about the students (which is normally distributed by different data sources) be stored in an appropriate data repository, maintaining a single view of the students;

(ii) The information be analyzed, using the appropriate data analysis tools, to obtain knowledge about a specific student or a group of students and the associated academic behaviours; (iii) That a set of adequate actions be automatically carried out, over a student or a group of students, when a specific situation, event or behaviour is detected; (iv) That the impact of all the actions that took place over the student/students be assessed and, if necessary, be redefined.

3.2 Proposed Architecture

The structural issues related with the data repository and the data analysis tools suggest that the *SRM System* must be implemented using the concepts and the technological infrastructure that traditionally support the *Business Intelligence Systems* (Negash and Gray, 2003). The *SRM System* architecture includes four main components: the *Data Acquisition and Storage* component; the *Data Analysis* component; the *Interaction* component and the *Assessment* component (Figure 1).

The *Data Acquisition and Storage* component is responsible for storing the students' data in a *data warehouse*, which structure was modelled for this purpose. The students' data exist in different data sources. All the data is stored in the data warehouse after the ETL (*Extraction*, *Transformation* and *Loading*) process. The *Data Analysis* component is responsible for obtaining knowledge about the student/students. The stored data is analyzed using appropriate data analysis tools, allowing patterns identification. The obtained knowledge is stored in an adequate data repository (*knowledge database*). The data analysis tools allows: statistical analysis, querying, reporting, analysing data under different perspectives and views (using *OLAP* tools), identification of students' profiles and behavior's patterns (through the identification of patterns and trends that exists in data using *data mining* techniques). The *Interaction* component is responsible for maintaining an adequate and effective relationship with the students, using the obtained knowledge. The system must allow the definition and the automatic execution of adequate actions over the student/students. These are practicable using technological tool that allows the interaction and communication between the different users, as well as automatically execute personalized actions. The *Assessment* component is responsible for the assessment of all the actions carried out and their impact, by monitoring the students' academic behaviour - verifying different rates (assiduity, marks, among others). The using tools allow the monitoring of different indicators, statistical analyses and reporting.

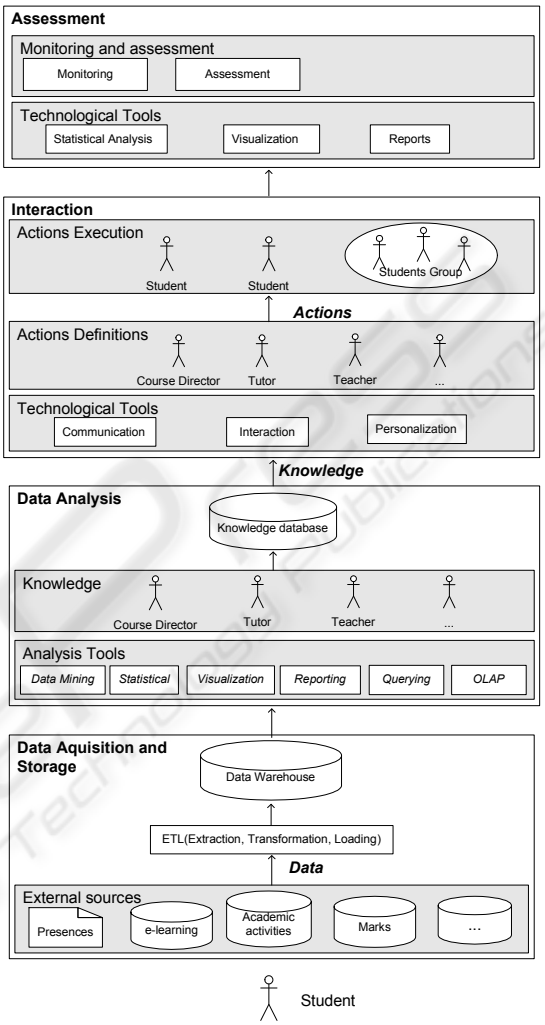

Figure 1: The SRM system's architecture.

3.3 Implementation

The *SRM System* has been implemented mainly by *Business Intelligence* tools and development tools. For reasons that are subjacent to the development context, the choices were the integrated environment supported by *Microsoft* tools, namely the *SQL Server Business Intelligence Development Studio*, and the *Visual Studio .NET*. The first includes a set of integrated components (*Database Engine*, *Integration Services*, *Analysis Services*, *Reporting Services* and *Notification Services)* for developing and managing *Business Intelligence* solutions. The *Database Engine* component provides support for relational and multidimensional databases (in this

particular case support the *data warehouse* and the *knowledge database* implementation and maintenance); the *Integration Services* component supports the ETL process; the *Analysis Services* component supports the *data warehouse* exploration/analysis (through *OLAP* and *data mining* tools); the *Reporting Services* component supports the reports design, management and delivering; and the *Notification Services* component supports users notification processes (sending personal messages, when some event happens) (Mundy, Thornthwaite and Kimball, 2006). The *Visual Studio.NET* supports the *web* application development, once it is expected that the *SRM System* results in an application fully integrated in the *web* environment.

4 APPLICATION CASE

To demonstrate the *SRM concept* relevance, its applicability in a real context was carried out.

4.1 Application Case Domain

This application case was carried out in a Portuguese Higher Education Institution, namely in a graduate course of the computer science field. Each course integrates a set of units, or signatures. The selected unit includes 139 students and runs through a presential component and an *e-learning* component. The presential component activities include, among others: curricular subject explanation, exercises development, projects implementation, laboratory experiences; tests and exams assessment. The *e-learning* component activities include, among others: access to general information about the course unit, access to detailed information of the curricular topics and lessons, projects guidelines, exercises, homework, quizzes and a discussion forum.

4.2 Data Collection, Acquisition and Storage

The available data, about each student and his/her involvement in the *teaching-learning* process, was (i) provided by the institutional information system and include students' personal information and unit information; (ii) obtained by the teacher (information related with the presence in classes, the developed activities and the corresponding assessments); (iii) provided by the *e-learning* system (information related with the consulted materials, *web logs*, analysed exercises).

The analysis of all the available data allowed the identification of the data subset that was considered in the application case. The subset considered crucial to the analysis includes:

(i) Personal Information: *student_number* (student number identification), *situation* (worker/full-time student), *registration_year* (student registration year) and information about the units in which the student is registered. In a normal situation, a student that has a registration year with the values 2 or 3 means that the student is at the *first* time in the unit, values 4 and 5 means that the students are *repeating* the unit. In order to maintain the student's privacy, all the information that allows his/her identification is ignored or codified.

(ii) Unit or Signature Information: *id_unit* (unit identification), *designation* (unit name), *year* (curricular year), *semester* (curricular semester), *course* (associated course).

(iii) Presences in unit classes' information: *assiduity_rate* (presential classes' assiduity rate related to each student, the percentage value) and Assiduity type information: *idAssiType* (assiduity type identification), *description* (assiduity type description), *range* (related range). In this particular application case were used the descriptions: *VeryLow (0% - 25%)*, *Low (> 25% - 50%)*, *Acceptable (> 50% - 75%)*, *High* (*> 75% - 90%*) and *VeryHigh* (*> 90% - 100%*).

(iv) Assessment Information: *id_assessmentActivity* (assessment activity identification), *description* (activity description), *weight* (weight in the final mark), *mandatory* (obligatorily indication, yes/no) and relating information about the *marks* obtained by each student. The *mark* scale comprises values among 0 to 20. To represent some specific situations, it was used a negative value; *-2* for the students that are *not allowed* to do the next exams, due to the lack of a positive project classification or because he/she missed most of the presential classes; *-1* for the students that *fail* the evaluation, due to the lack of a positive written test classification (but, they could pass in next exams). Values greater or equal then 10 represent that the students have a positive mark. In a qualitative scale, mark values between 10 and 13 correspond to *Satisfactory*, between 14 and 16 correspond to *Good*, and between 17 and 20 correspond to *Very Good*.

(v) *E-learning* Information: *id_action* (*e-learning* action identification), *action* (*e-learning* action), *description* (action description) and relating information about the number of accesses (*actions*)

undertaken by each student. It was considered that 0 to 35 accesses corresponds to a *few* number of accesses, 36 to 57 corresponds to an *expressive* number of accesses and values greater than 57 corresponds to *many* accesses (accordingly with the values distribution). After the identification of the relevant data, it was (i) designed the *data warehouse* model (a multidimensional data model), which follows the *constellation schema* represented in Figure 2.

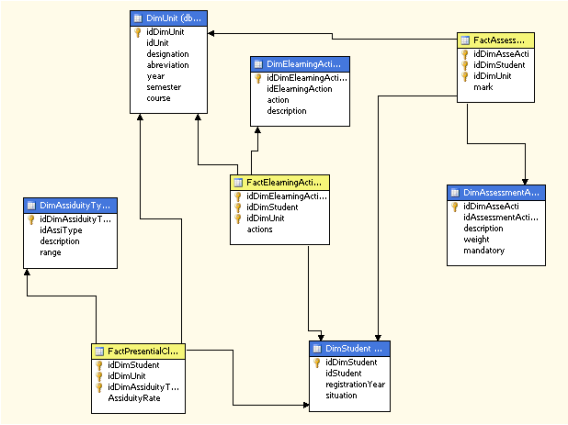

Figure 2: Data warehouse model.

(ii) Implemented the *data warehouse*, through the *dimensions* and *facts* tables' creation. This process is supported by the *Database Engine* component. (iii) Loaded the *data warehouse*. The loading process follows the steps of the ETL process, in which the relevant data is extracted from the source databases. After the extraction, the data is cleaned (when errors in data are detected) and transformed in order to accomplish the format of the target system, the *data warehouse* system. The last step is associated with the loading process. These processes were supported by the *Integration Services* component through the development of several packages.

4.3 Data Analysis

To explore the *data warehouse* it was used *OLAP* and *data mining* techniques.

4.3.1 OLAP

The *OLAP* analysis main purpose is to understand the unit students' behaviour and the influence of the adopted *teaching-learning* experiences. To analyse the correlation between the classes' presences, the accesses to the *e-learning* platform and the students' evaluation, a cube was created. The cube integrates the classes students' presence (represented by the *AssiduityRate* fact), the assiduity type description (represented by the *Description* attribute with the values *VeryLow, Low, Acceptable, High, VeryHigh)*, the accesses to the *e-learning* platform (represented by the *Actions* fact) and the final results (represented by the *Mark* fact) of the final test evaluation (represented by the *id_assessmentActivity* attribute with value *500*, in the *Filter Expression*). Figure 3 and 4 represents an extract of the cube data.

			VeryLow			Low			Acceptable			Higher		
Id Student	Registrati	Situation	Assiduity R	Actions	Mark	Assiduity R	Actions	Mark	Assiduity R	Actions	Mark	Assiduity R	Actions	Mark
102	4	full_time_student	0	0	-2		0	-2		0	-2		0	-2
202	3	worker_student	0	0	-2		0	-2		0	-2		0	-2
209	3	full_time_student	0	0	-2		0	-2		0	-2		0	-2
501	3	full_time_student	0	0	-2		0	-2		0	-2		0	-2
603	5	full_time_student	0	0	-2		0	-2		0	-2		0	-2
801	3	worker_student	0	0	-2		0	-2		0	-2		0	-2
1011	5	worker_student	0	0	-2		0	-2		0	-2		0	-2
1014	5	full_time_student	0	18	-2		18	-2		18	-2		18	-2
5017	5	full_time_student	0	0	-2		0	-2		0	-2		0	-2
5018	2	full_time_student	0	0	-2		0	-2		0	-2		0	-2
7018	5	full_time_student	0	0	-2		0	-2		0	-2		0	-2
208	5	worker_student	9.52	26	-2		26	-2		26	-2		26	-2
401	3	worker_student	14.29	36	-1		36	-1		36	-1		36	-1
503	2	full_time_student	14.29	45	-2		45	-2		45	-2		45	-2
2019	2	full_time_student	14.29	53	-2		53	-2		53	-2		53	-2
3011	2	full_time_student	14.29	62	-2		62	-2		62	-2		62	-2
407	5	worker_student	19.05	133	-1		133	-1		133	-1		133	-1
601	5	worker_student	19.05	44	15		44	15		44	15		44	15
2015	5	worker_student	19.05	8	-2		8	-2		8	-2		8	-2
207	3	worker_student	23.81	45	-1		45	-1		45	-1		45	-1
307	3	worker_student	23.81	63	-1		63	-1		63	-1		63	-1
7017	2	full_time_student	23.81	0	-2		0	-2		0	-2		0	-2
1015	3	worker_student		0	12	28.57	0	12		0	12		0	12
3014	2	full_time_student		59	-2	28.57	59	-2		59	-2		59	-2
2010	5	worker_student		18	14	33.33	18	14		18	14		18	14
5019	4	full_time_student		0	-2	38.1	0	-2		0	-2		0	-2
7012	3	full_time_student		68	-1	38.1	68	-1		68	-1		68	-1
3016	3	worker_student		93	-1	42.86	93	-1		93	-1		93	-1
7013	5	worker_student		41	13	42.86	41	13		41	13		41	13
704	5	worker_student		54	13	47.62	54	13		54	13		54	13

Figure 3: Extract of students data grouped by *Very Low* and *Low* assiduity rate.

			VeryLow			Low			Acceptable			Higher			VeryHigher		
Id Stude	Regist	Situation	Assiduity	Actions	Mark	Assiduity	Actions	Mark	Assiduity	Actions	Mark	Assiduity	Actions	Mark	Assiduity	Actions	Mark
605	4	full_time_stud	29	15		29	15		29	15		85.71	29	15		29	15
705	3	full_time_stud	116	15		116	15		116	15		85.71	116	15		116	15
708	2	full_time_stud	0	15		0	15		0	15		85.71	0	15		0	15
709	3	full_time_stud	60	13		60	13		60	13		85.71	60	13		60	13
802	3	full_time_stud	43	12		43	12		43	12		85.71	43	12		43	12
2011	4	full_time_stud	80	13		80	13		80	13		85.71	80	13		80	13
2013	4	full_time_stud	28	16		28	16		28	16		85.71	28	16		28	16
2017	3	full_time_stud	83	15		83	15		83	15		85.71	83	15		83	15
3019	3	full_time_stud	29	16		29	16		29	16		85.71	29	16		29	16
4016	3	full_time_stud	38	16		38	16		38	16		85.71	38	16		38	16
4019	3	full_time_stud	39	17		39	17		39	17		85.71	39	17		39	17
5010	3	full_time_stud	51	13		51	13		51	13		85.71	51	13		51	13
5015	5	full_time_stud	40	14		40	14		40	14		85.71	40	14		40	14
6012	3	full_time_stud	46	-1		46	-1		46	-1		85.71	46	-1		46	-1
6018	2	worker_stude	41	14		41	14		41	14		85.71	41	14		41	14
7014	3	full_time_stud	61	15		61	15		61	15		85.71	61	15		61	15
106	2	full_time_stud	90	13		90	13		90	13			90	13	90.48	90	13
204	3	full_time_stud	47	-1		47	-1		47	-1			47	-1	90.48	47	-1
206	3	full_time_stud	49	15		49	15		49	15			49	15	90.48	49	15
309	2	full_time_stud	62	14		62	14		62	14			62	14	90.48	62	14
506	3	full_time_stud	42	16		42	16		42	16			42	16	90.48	42	16
602	5	full_time_stud	49	17		49	17		49	17			49	17	90.48	49	17
702	3	full_time_stud	25	16		25	16		25	16			25	16	90.48	25	16
1010	3	full_time_stud	37	16		37	16		37	16			37	16	90.48	37	16
2014	3	full_time_stud	50	14		50	14		50	14			50	14	90.48	50	14
2018	2	full_time_stud	71	14		71	14		71	14			71	14	90.48	71	14
4012	4	full_time_stud	32	13		32	13		32	13			32	13	90.48	32	13
6010	3	full_time_stud	66	14		66	14		66	14			66	14	90.48	66	14
201	4	full_time_stud	57	17		57	17		57	17			57	17	95.24	57	17
301	3	full_time_stud	31	17		31	17		31	17			31	17	95.24	31	17

Figure 4: Extract of students data grouped by *High and Very High* assiduity rate.

From the analysis of Figure 3, it could be seen that a great number of students with a *VeryLow* and a *Low* assiduity rates *fail* the evaluation (*mark* value *-1*) or are not allowed to do the final exams evaluation (*mark* value *-2*). There are only four students (IDs *601*, 2010, *7013* and *704*), with these characteristics, that have a positive mark, passing the unit. These students are repeating the unit (since they have the value *5* in the attribute *Registration Year*), fact that could explain their final mark. Another fact is their expressive number of unit interactions through the *e-learning* platform. Having in attention that these students are *worker_students*, it could be concluded that the *e-learning* platform is a good complement to the presential classes, particularly for this kind of

students. In addition, it could be seen in Figure 4, that a very expressive number of students with *High* or *VeryHigh* assiduity rates have a positive mark and that many of these students have *Good* marks. There is only a student (ID 6012), on these conditions, that *fail* (mark value -1).

4.3.2 Data Mining

The *data mining* analysis main purpose is to identify the profile of the students in order to decrease the unit failure rate. For that, it was implemented a *classification* task (Han and Kamber, 2001) to identify a model that classifies the students' evaluation profile, including the values that are associated with the students' failure (*Not Allowed*), the students with failure risk (*Fail*) and the students with success (*Pass*).

The knowledge discovery process follows the traditional *Knowledge Discovery in Databases (KDD)* steps (*Data Selection*, *Data Treatment*, *Data Pre-Processing*, *Data Mining* and *Results Interpretation*). The *classification* task requires finding a model that describes the predictable attribute (in this case the *Mark* attribute) as a function of the input attributes (in this case, the *registration_year*, *situation*, *assiduity_rate* and *actions* attributes). To carry out the classification task it was selected the *decision tree* algorithm. Based on the patterns (in this case a set of rules) represented by the decision tree, it can be possible to identify the students' evaluation profile. The obtained model (Figure 5) integrates a set of rules (in a tree form). From the analysis of the model, it was selected the following set of rules that explicitly describes the patterns:

(i) *Not Allowed*:

1. IF *assiduity_rate* = 'VeryLow' and *Accesses* < 35 THEN *mark*= 'NotAllowed';
2. IF *assiduity_rate* = 'VeryLow' and *Accesses* >= 35 and *registration_year*= 'second' then *mark*='NotAllowed'.

(ii) *Fail*:

1. IF *assiduity_rate* = 'VeryLow' and *Accesses* >= 35 and *registration_year* not= 'second' THEN *mark* ='Fail';
2. IF assiduity_rate= 'Acceptable' and *registration_year*= 'second' THEN *mark*='Fail'.

(iii) *Pass*:

1. IF *assiduity_rate* = 'VeryHigh' and *Accesses* < 35 or >= 57 THEN *mark* = 'Pass';
2. IF *assiduity_rate* = 'Acceptable' and *registration_year* not= 'second' and situation ='full-time' THEN *mark*= 'Pass';
3. IF *assiduity_rate*= 'VeryHigh' or 'High' and *Accesses* >= 35 and < 57 and *registration_year* = 'third' THEN *mark*= 'Pass'.

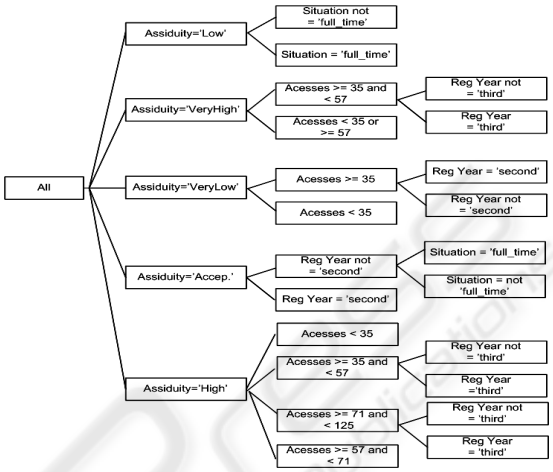

Figure 5: Students' profile tree model.

From the rules analysis, it is verified that the attributes *assiduity_rate* and *accesses* are the attributes that more influence the students' profile. A very low assiduity rate and few interactions with the *e-learning* platform, is the typical profile of the students with failure (*Not Allowed*). This situation occurs, in a more emphasized form, when the students were in the second registration year independently of the interaction level. The student profile with failure risk *(Fail)* is associated to students in the 3, 4 and 5 registration years and with lower assiduity rates, but with an expressive interaction level with the *e-learning* platform. In the same situation are the students in the second registration year with an acceptable assiduity. The students profile with success (*Pass*) is associated with students with higher assiduity rates and that have either few or many interactions levels. In particular, the students in the third registration year and with an expressive interaction level were the students with more success. In the same situation are the full-time students in the 3, 4 and 5 registration years, with an acceptable assiduity rate.

4.4 Interpretation of Results

The *OLAP* and *data mining* analyses lead us to conclude that it is necessary to take special attention to the students with low classes' presences and/or students which do not interact or interact few with the *e-learning* platform. In this special case the

teacher could, for example, send an alert messages to the students (calling their attention to the importance of the presential classes/interaction mechanisms) or the tutor (teacher responsible by the student) could to see what is happening with the students in order to support them (all these activities are included the *SRM practice*). It is also necessary to take special attention to the students in the second year and also with the worker-students. All these situations must be handled, without neglecting the students that usually have a success profile. The previous results allow us to conclude that data analysis supports the process of obtaining knowledge about the students and their academic behaviour. Next steps, in this project include: i) the integration of other types of information about the students in the data analysis process ii) adding the interaction capability to the prototype, following the set of activities defined in the *SRM practice*. Those activities are associated with automatic actions that are carried out over a student or a set of students presenting the same behaviour. One of these actions could be the automatic e-mailing of messages to students that present little interaction with the course unit or do not have any interaction at all.

5 CONCLUSION AND FUTURE WORK

In a Portuguese higher education context, there exists a strong budget control inside the institutions and also a strong competitiveness among institutions. Another characteristic is that persist a high rate of failure and abandon (mainly in the firsts graduation years). It is required that the institution adopts measures that help to invert this trend. It is also known that the teacher staff (already overloaded with teaching, researching and managing tasks) plays an active role in the success promotion. In this context, we believe that the implementation of the *SRM practice*, supported by the proposed *SRM system*, create an advantage towards the students' success promotion, and therefore in the institution success, once the system facilitates the students' knowledge acquiring process, the actions/decisions support and the subsequent interactions with the students. The development of this project has occurred in different stages. In the first stage it was proposed the *SRM* concepts and its validation. It was also verified that no adequate technological support to the *SRM concept* and *practice* (such as defined and understood on the scope of this work) exists. The second stage was associated with the definition of the structural framework, which allowed the definition of the *SRM system* architecture and its main functionalities. It was also identified and defined the technological tools used in the prototype implementation. At this moment, the *SRM system* prototype is under development. After that, it will be validated through the execution of a set of demonstration cases in different higher education institutions.

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