Monitoring Student’s Curricular Performance in Higher Education

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Abstract Nowadays higher education students are exposed to high levels of stress, and are constantly harassed with distractions that compromise objectives and performance levels found in terms of study and learning outcomes. Correspondingly, higher education institutions do not have at their disposal appropriate tools to follow in real time students’ curricular performance. This provides a significant delay in problem identification and will, in turn, have a negative impact on the institutions quality. The problem can be addressed by using a business activity monitoring system that monitors the curricular performance of students throughout their academic endeavor. By providing teachers and students with an informational cockpit that outlines a set of indicators, providing clear context awareness about their performance, we allow them to follow their evolution and progress in accordance with the acquisition of knowledge objectives expected by each Higher Education Institution. Allied with alarming mechanisms, such a cockpit would greatly increase the control students and institutions would have on their activities. By applying corporate concepts used today in the business world, we propose a real time business activity monitoring tool by defining key structural elements such as information models, activity monitoring models and dashboard design applied to a higher education environment.

Keywords: Business Activity Monitoring, Higher Education, Dashboard, Indicators, Information Model.
1 Introduction

This thesis proposes a monitoring model solution to follow the curricular performance of a higher education student. This document is structured logically to allow the reader to understand the problem addressed and its challenges, followed by a clarification of the concepts involved and their pertinence in the market today, and ending in the solution proposal and evaluation methodology as a result of the work done.

1.1 Context

The curricular performance of higher education students (HES) does not always meet expectations, be it by the university, professors, or the student itself. This may be caused by a plethora of reasons, some of which include lack of planning and monitoring of the academic endeavor. This is a situation that is undesirable not only by the student itself that will suffer from poor performance, but also by the institution in which he is enrolled, since the said performance reflects on the institution’s quality and reputation. This is a common situation in education however little research has been done on how this problem can be solved.

This thesis focuses, for that reason, on developing research work on the subject, by modeling a business activity monitoring (BAM) tool to visualize important information relative to HES performance through the use of dashboards. A dashboard will, therefore, be used as a tool to support the management and monitoring of higher education activities and, as such, assume the role of a personalized informational cockpit adapted to a user profile (teacher, student, manager). This dashboard features information presentation through key indicators (in a graphical form) and through alerting capabilities, allowing analysis, control and visibility over curricular activities.

The development of this work involves researching concepts and best practices related to the topic of BAM, dashboard and model construction; case study analysis of FénixEDU an academic management system developed by Instituto Superior Técnico (Lisbon Tech); and surveying existing systems and performance indicators used by higher education institutions;

For the proposal of the monitoring tool, a five step procedure was defined for the creation of a model. This procedure involves the characterization of the approach towards the definition of an information model, definition of monitoring objects, dashboard design, definition of events, and data and presentation rules. For the modeling work the tool Enterprise Architect 10 is used, and in accordance with the design science research methodology, in which we follow its seven guidelines for the creation and validation of three artifacts: information model, monitoring model and dashboard design.
1.2 Research Challenges

Student pedagogic and curricular success is measured by the necessary and expectable knowledge acquisition throughout the academic endeavor. Control over this knowledge acquisition is critical and must be done in order to ensure the fulfillment of objectives within a higher education institution. This control needs to be present in two main perspectives. From an institution’s perspective (stakeholders include teachers and managers) there are concerns with the quality and performance of its education which is positively correlated with the performance of its students. From the students’ perspective (in which the stakeholders are higher education students) there are concerns with personal curricular accomplishment and achieving the highest possible grade as well as acquiring knowledge. Each perspective has its own concerns and problems, and hence different informational needs. We approach each perspective in the following paragraphs.

From the institutions perspective

Most evaluation plans in higher education institutions produce and revise student grading at the end of an academic term (typically a semester). In these plans the degree to which a student is considered to be successful is contingent upon how good their final grades are. This information is commonly used to identify areas and students that are having poor academic performance. Higher education institutions are not sufficiently aware about the relevance of personalized tracking and monitoring of each student’s progression. In most situations there is a lack of tools, endowed with alarming mechanisms, capable of acting preemptively when confronted with a deficient student’s plan and progress in an early stage of development. One of the inherent disadvantages associated with this type of reactive evaluation, is the fact that by the time this is done it is too late to address the underlining causes of unsuccessfulness of the academic term.

From the student perspective

With the current demand of a competitive professional market, higher education students are increasingly being overloaded with large amounts of tasks and information as well as other distractions that require their attention. This situation has the potential of not only decreasing the study efficiency but also makes it difficult to put in effect an adequate study plan. The lack of planning capabilities and the need for academic integration further aggravate this state, and students are faced with the inevitable situation of falling behind on their studies. Since students do not have at their disposal control and monitoring mechanisms related to their academic endeavor they will, at some point, be faced with missing project and report deadlines, lack of study, lack of planning and time allocation to study.

Why is it a problem

• When events with negative performance are identified it is usually too late to address the underlining causes. This reactive evaluation causes a lag between problem identification and problem resolution;
• One or the major criteria to classify Higher education institutions is normally based on a ranking defined by the quality of its graduates. Lack of monitoring and problem resolution may mean a decrease in the quality of education and hence the quality of an institution;
• Students usually fall behind on their studies due to lack of control mechanisms relative to their academic endeavor;
• Lack of monitoring capabilities can account for deficient and untimely decision making.

How to address the problem.

The use of automatic monitoring and alarming mechanisms capable of presenting aggregated and systemized data to support, in real time, stakeholders information needs. This type of monitoring can be implemented using a set of indicators configured in accordance to the role and profile of stakeholders by:

• Providing teachers with an informational cockpit with information about the student’s progress and performance. The use of key indicators helps at accomplishing this goal, allowing simultaneously to get a good perception about each student learning progress and with additional information in relation to average teaching standards;
• Providing students with an informational cockpit with information designed to cope with their learning concerns. Such approach also allows them to monitor how well they are performing in relation to the thresholds defined in their area;
• Providing alerting mechanisms to teachers and students that preemptively notify them, with different levels of severity, of low performance areas and risks.

This leads to the need of having a set of classification information, namely: metadata about the student’s profile, metadata about the business rules, and metadata of the informational cockpit.

1.3 Goals Addressed Within This Thesis

This thesis aims at improving the pedagogic performance of higher education students by providing a specification of a real time activity monitoring model, adapted to a higher education context by achieving the following goals:

• Specify an information model to support higher education business activities and events;
• Conceptualize a solution for a real time activity monitoring model, supported by the defined information model;
• Design a graphical visualization interface (i.e., dashboard) capable to support stakeholders’ information needs according to their role and expectation to reach established goals.
  — Institution: achieve high quality standards and gain reputation;
  — Teacher: career progress through pedagogical excellence, research recognition;
— Student: conclusion of studies within the right time, acquisition of knowledge, and achieve the best possible results;

We will be focusing mainly on the students’ perspective but, as said above, students’ results reflect on their teachers and on their institutions. The achievement of these goals opens the possibility for comparative analysis between students’ progress, not only in their current year, but in previous years as well. Consequently, in the teacher’s perspective, it will be possible for a better and personalized pedagogic performance monitoring of the student.

2 Related Work

2.1 Business Activity Monitoring

Business Activity Monitoring (BAM) was first coined by Gartner as a term to define real-time access to critical business performance indicators to improve the speed and effectiveness of business operations [18]. BAM features its information display through the use of dashboards containing key indicators (KI), assuring activity and performance visibility.

A BAM system collects data from multiple sources which, given a context, results in capturing events [10]. Events are occurrences in time and in a given context that can be monitored and analyzed using business rules and indicators. This analysis allows the correlation between events so that tendencies can be detected and predictions can be made on the outcome of certain events. This thesis will extend a four step procedure described by [3], by adding an additional step that involves the definition of the underlining information model of the monitoring objects.

2.2 Indicators

In order to effectively monitor a business activity it is essential to have business indicators. We can divide these into two types: basic indicators which are the direct result accessing a measure value (or metric), and derived indicators which are the result of the computation of basic or derived indicators. Derived indicators are typically associated to key indicators (KI) [17]. A KI is an indicator that is relevant to an organization’s goal and objectives, and for the purpose of this thesis three types of Key Indicators will be worked with, these are Performance Indicators (KPI), Risk Indicators (KRI) and Control Indicators (KCI). KI are correlated with different analysis perspectives that can be characterized in a three level information structure: Operational, Tactical, Strategic;

These must be displayed in a manner that is adequate to a given context and role [1], efficient and easy to use, and must be presented in a way sufficiently intuitive so that no additional “know-how” is required. This is why indicators are typically represented by graphical objects via user interfaces.
One such form of graphical interface is designated as Dashboard. Stephen Few [12], one of the leading experts in this subject, defines it as being:

“... a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance.”

The display mechanisms should be clear, intuitive and appropriate to the context of the information, as well as adapted to the specific requirements of a given person, group or function [12].

2.3 Information Modeling

An Information Model is a generally formal and abstract representation of entities and their relations, which can include properties and operations. In [19] an information model is defined as being:

“(…) a representation of concepts, relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse.”

Using an information model provides an organized and stable structure of information that has the advantage of being able to be integrated with identical or similar structures. Mainly three types of model methodologies have been used in recent years: object-oriented (OO), entity-relationship (ER), and functional modeling [19]. We focus on the first two.

Activity Monitoring in Portuguese Higher Education Institutions

In order to assess the current state of activity monitoring in higher education in Portugal, a preliminary study was made with the purpose of finding which academic platforms are used in institutions in the area of Lisbon. The results obtained show that the majority of institutions use either NetP@ or Moodle. These services were found to be of management and logistical nature, and no evidence was found for real-time monitoring capabilities.

2.4 State-of-the-art

Business Activity Monitoring

Performance measurement has been a big concern for companies, particularly big organizations that deal with large amounts of data, and with today’s highly competitive market no one can afford to lose visibility over their business. Because of this, it is no surprise that companies use monitoring systems to take control over their activities.
Dashboard
There are two types of dashboards available in the current market: static dashboards in which there is no interaction with the information displayed, and its purpose is solely to present information be it in real-time or not; and a more cutting edge type of dashboard designated by Business Intelligence Dashboard. BI Dashboards differ from basic dashboards in terms of interactivity and real-time on the spot querying. These allow for drilldown and rollup types of search as well as filtering and ordering by interacting with the dashboard components, it may also permit visual customization such as changing colors and position of each graphical component.

3 Proposed Architecture for a Higher Education Performance Monitoring Tool

The solution involves the creation of a higher education student monitoring model and a dashboard interface for indicator visualization. The dashboard presents key indicators (KPI, KRI and KCI) relative to a student’s performance in its curricular activities. Such activities include, but are not limited to, class attendance, study performance, exam/test attendance, weekly hour reporting, project submission, evaluation results. These are subject to isolated monitoring analysis (e.g. a dashboard relative only to the personal performance of a student) or comparative monitoring analysis (e.g. dashboard with information about the performance of a set of students). Each KI has associated thresholds to limit optimal value ranges that, in conjunction with alarming mechanisms and visual displays, provide a way of showing poor performance areas that need attention from either the student or teacher.

KIs are assigned to different contexts (e.g. course, class, curricular year, etc.) and with regard to a specific user profiles (i.e. student and teacher), allowing for different analysis perspectives: operational, tactical and strategic (Annex Error! Reference source not found.).

Context and profile is characterized in descriptive metadata associated to the dashboard. Context awareness assumes a fundamental role in the definition of this model, since information does not have the same importance for every user role and even for same user roles in different contexts. For instance, for a first year student it is important to have at his disposal mainly operational indicators about his performance in various classes. For a final year student however, his interest lie mainly in analysis of classes done and his progress throughout his studies, which require indicators of tactical or strategic nature.

Navigation is possible between different perspectives through drilldown capabilities. This allows, for example, for a teacher, that is visualizing his class dashboard (with information about all his students), to focus on a single student by selecting him and being presented with another dashboard with KI relative to that student.
A monitoring system must exist to capture and process events in order to translate these into KI which are then used by dashboards. For this reason we present two models to support the presentation of information: monitoring model and information model. The monitoring model will conceptualize how, when and which events are treated as well as defining what objects are subject of monitoring. The information model will define how such objects and events are structured and characterized.

4 Case Study: Instituto Superior Técnico FénixEDU

FénixEDU is used as a starting point for the development and application of the proposed model. The existence of student key indicators and the lack of a monitoring tool make it an ideal system to study the implications of the solution proposed by this work. The case study involves the use of the proposed architecture in real scenarios by designating KI to different roles in the institution.

5 Conclusions

The research work allows the specification of a conceptual model to monitor the performance of higher education students. The model supports the management and monitoring of higher education activities by defining a dashboard interface as a means to display vital information to an organization and, as such, assumes the role of a personalized informational cockpit adapted to a user profile (teacher, student, manager). It features information presentation through key indicators (in a graphical form) and through alerting capabilities, allowing analysis, control and visibility over curricular activities.

Not only does this project aim at contributing with a technological tool specification, but also at helping students to create good planning, management and
control habits in their curricular activities, thus increasing their performance in their curricular endeavor.
References
