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Editors:
Su Mi Dahlgaard-Park
Jens J. Dahlgaard
Boštjan Gomišček

LUND UNIVERSITY
University of Maribor
Linköping University

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Dropout Prevention and Higher Education Quality Management Systems

Rogério Duarte
Department of Mechanical Engineering
Escola Superior de Tecnologia de Setúbal, Instituto Politécnico de Setúbal
Setúbal, Portugal
rogerio.duarte@estsetubal.ips.pt

António Ramos-Pires
Department of Mechanical Engineering
Escola Superior de Tecnologia de Setúbal, Instituto Politécnico de Setúbal
Setúbal, Portugal
antonio.pires@estsetubal.ips.pt

Helena Gonçalves
UNIQUA
Instituto Politécnico de Setúbal, Setúbal, Portugal
helena.goncalves@sc.ips.pt

Abstract

Purpose: To present a process for the detection of at-risk (of dropout) students and to discuss the integration of this process within the framework of higher education institutions' quality management systems.

Design/Methodology/Approach: Based on literature review factors that determine students' dropout are introduced and discussed. A process for the detection of at-risk (of dropout) students using institutional information systems' data is presented. A case study using a sample of 293 non-traditional students of a four years graduate course exemplifies the implementation of the at-risk student detection process.

Findings: There are good prospects of identifying at-risk (of dropout) students using solely institutional information systems' data. The integration of dropout prevention processes and higher education institutions' quality management systems is advantageous.

Research limitations/implications: The case study used data from a population of non-traditional students with homogeneous demographic characteristics. Further research should clarify if institutional information systems' data remains appropriate for predicting dropout in populations with heterogeneous characteristics.

Practical implications: Dropout prevention is much more cost effective than attracting new students. The process of at-risk student detection contributes to inform decision making and to the implementation of dropout prevention programmes.

Social implications: Education is fundamental for civilisational progress and for the promotion of individuals. For freshman, academic failure can trigger positive feedback re-enforcing previous academic and social failures that lead to dropout. The possibility of preventing academic failure and student dropout contributes to the mission of public higher education institutions.

Originality/value: This paper shows that it is possible to use simple models to inform decision making on the complex subject of student dropout. The originality of the paper lies in finding a specific situation for which the simple model applies, and in integrating research findings within the framework of higher education institutions' quality management systems.

Keywords: Higher education, non-traditional students, dropout prevention, quality management systems, academic analytics

Paper type: Case study

Introduction

Due to its time cycle and to the complex interrelations between teacher, student and institutional environment, the teaching and learning process is among the most complex to be managed. It is therefore no surprise that researchers report difficulties with the implementation of this process within the framework of higher education quality management systems (Owlia, 1996; Newton, 2002; Hoecht, 2006). Frequent justifications for failure are teachers' culture and autonomy, or the lack of supporting leadership. But if one takes a closer look, the failure also stems from the lack of diagnosis tools and from the lack of accepted best practices when intervention in the teaching and learning process is needed.

To be successful, a quality management system needs to find the right balance between academic freedom and accountability; a significant contribution to this balance comes from designing processes that convey clear and largely acceptable messages. At the Polytechnic Institute of Setúbal (IPS) the quality management system was designed with the following two fundamental ideas: profound knowledge of the variables with impact on the results; and, management based on facts. The adopted attitude was to "stimulate disequilibrium with information" (Snyder, 2000, p. 320); therefore, monitoring became a fundamental element in IPS' quality management system. To increase insight and "make reality visible" it was decided to use the monitoring data in applied research. One of the first research results was the 2009-2010 exploratory study which aimed at identifying the causes of student's dropout (Pires, 2011). With the completion of this study it was decided that such analysis should be continuous in time.

Higher Education Institutions (HEIs) contemporary reality is one of continuous change; external pressures (e.g., governmental, socio-demographic, economic) shift student population characteristics and the courses offered have to adapt to the new characteristics. For many HEIs the commitment to lifelong learning has led to a significant increase in the non-traditional population (older, part-time, commuter students), and to the adoption of new teaching methodologies.

Due to their age, the circumstances under which they accessed higher education and their need to reconcile family, job and academic responsibilities, non-traditional students have needs that set them apart from traditional HEIs' population. Mature part-time commuter students, with less opportunities to interact with the higher education environment and with less opportunities to socialise with peers and faculty, present a much more consumer-centred approach; their view of education is closer to that of a product to be consumed and if they are not satisfied with their experience the chances of dropout are significantly increased (Anderson, 2011). As non-traditional students become a larger percentage of HEIs' population, concern about dropout grows; student dropout moves to the top of many HEIs agendas.

Within the framework of its quality management system, IPS started the development of a dropout prevention programme. A small-scale study was designed with the objective of

identifying at-risk (of dropout) students and understand the use that data gathered (solely) from the institutional information system had. A technological course designed for non-traditional students was selected for the study. Students' grades, enrolment data and personal data were collected from the institutional information system. A model for student dropout was selected and the process for the detection of at-risk student was implemented.

This paper describes a process of at-risk (of dropout) students detection using data collected (solely) from the HEI information system, and discusses the implementation of this process within the framework of a HEI's quality management system. The paper starts by introducing the topic of student dropout modelling and discusses those factors that according to the scientific literature are relevant when studying non-traditional students. Dropout prevention programmes are discussed next, and a specific process for the detection of at-risk (of dropout) students is presented within the framework of a HEI's quality management system. The experience gathered from a small-scale study developed at IPS is used as a case study for continuous detection of at-risk students. The paper's conclusions discuss the importance of dropout prevention programmes and the facilitating role quality management systems can have when implementing these programmes.

Dropout models

Student dropout is a topic of intense research. Developments in the last decades have led to a better understanding of the reasons (cultural, economic, social and institutional) that lay behind a student's decision to dropout. Two related dropout research branches are (i) the development of models explaining the reasons (and interconnections between these reasons) that lead to student dropout; and (ii) the development dropout prevention programmes. This section deals with the models of student dropout; specifically, with the constructs and variables considered in these models. Programmes for dropout prevention are discussed on the next section.

One of the most influential dropout models was proposed by Tinto (1975). Classified as integrationalist (Melguizo, 2011, p. 398), Tinto's model focuses on the interactions between students and the institutions; it considers student dropout as a result of dynamic and reciprocal interactions that take place over time between the students' personal characteristics, HEI's characteristics and the elements of the outside community that surround the student (e.g., family, friends and business and economic contexts) (Vasconcelos, 2009). According to Tinto (1975), an initial commitment to enrol and persist in higher education can be related with family backgroung, the individual values and previous secondary school experience. Contributing to the strengthening of the institutional experience are the student's academic integration – related to grade performance and intellectual development – and the student's social integration – related with interactions with peers and with faculty. According to Tinto, the extent to which a student is academically and socially integrated in the HEI will determine his commitment to graduate and his commitment to the HEI. This in turn influences the student's decision to dropout, or not to dropout (to persist).

In spite of the scientific results in support of Tinto's model, some contend that in its attempt to be an all encompassing model, as a whole, the model is difficult to apply (Brundsen, 2000, p. 307). Undoubtedly, the all encompassing attribute that Brundsen criticises is the reason why so many researches decided to use and adapt Tinto's model. Tinto's model was originally developed for residential HEIs, traditional students and 4 years courses. Since its publication several researchers adapted or extended the model to fit urban commuter HEIs, 2 years courses and non-traditional students.

Regarding the specific case of non-traditional population, Bean argues that this population is characterized by a "lessened intensity and duration of (…) interaction with the primary agents of socialisation (faculty, peers) at the institutions they attend" (Bean, 1985, p. 488). For these students, attending a HEI is less relevant for their self-development process of becoming a mature adult. Older, part-time commuter students that spend sometimes less than 12 hours per week at the HEI certainly perceive their interaction to the HEI differently. Tinto's model relies heavily on socialization and social interaction with peers and faculty to explain dropout. Non-traditional students lack the extent of socialisation traditional students have; it is plausible that other factor compensate for the reduction in importance of socialisation.. Among the dropout models developed for non-traditional students, one that is frequently mentioned is that of Bean (1985). Bean relates student' "intent to leave", academic and psychological outcomes to background, academic, environmental and social integration factors, and relates "intent to leave", the above mentioned outcomes and factors among themselves and with students' dropout. Metzner (1987) validate Bean's (1985) model and conclude that dropout is a function of Grade Point Average (GPA) and credit hours enrolled (background), as well as the utility of education for future employment (psychological outcome), satisfaction with student role (psychological outcome), opportunity to transfer (environmental), and (indirectly) age. Metzner also concludes that absence from class (academic), age (background), secondary school performance (background) and ethnicity (background) have an indirect effect on dropout through GPA.

Table 1 lists the variables that Metzner includes in the background, academic and environment factors.

Table 1. Variables included in the background, academic and environmental factors used in Bean's model for non-traditional students' dropout (Metzner, 1987).

Background	Academic	Environmental
Age, **hours enrolment**, educational goals, high *school performance*, *ethnicity*, gender	Study hours, study skills, academic advising, *absenteeism*, market & job certainty, course availability	Finances, hours of employment, outside encouragement, family responsibilities, **opportunity to transfer**

Table 1 shows that both background and environmental variables contribute directly to dropout (bold variables), however, considering the indirect effect through GPA (variables in italics), the influence of the background factor in dropout is probably higher than that of academic and environmental factors.

Tharp (1998) uses background enrolment data to predict persistence on a urban commuter HEI and arrives to results similar to those of Metzner (1987): first semester hours and first semester GPA were specially significant in predicting student dropout.

These results are relevant because the continuous assessment of characteristics relevant for the understanding of dropout and for the detection of at-risk (of dropout) students, depends on the availability of data. Traditional methods of student inquiry, based on questionnaires are unpractical for quick evaluation of a student's "downward trajectory" towards dropout. However, if variables such as enrolment data or GPA are influential in students dropout, it becomes possible to use the institutional information system to gather students' background (and even academic) data and predict students dropout. A process that enables the detection of at-risk (of dropout) students is discussed in the next section.

Integrating dropout prevention and quality management systems

dropout prevention programmes are the answer HEIs use to address in a systematic fashion existing dropout problems. Examples of programmes that have been tested are; the Mentor Program (Stephenson, 1996), the Supplemental Instruction Program (Blanc, 1983), or the Geometric Model of Student Persistence and Achievement (Swail, 2004). These are large scope programmes that go beyond dropout modelling. One thing all these programmes have in common is the need for information.

The availability of student data in HEI is a consequence not only of the technological development but also of the external pressure for accountability (Hawkins, 2008). In Europe, the 2005 guidelines for the introduction of institutional quality management systems in HEIs (ENQA, 2005) specify the use of information system capable of collecting and analysing relevant information. A specific field of research that has emerged recently is that of "educational data mining" (Backer, 2009) and "academic analytics" (Goldstein, 2005), which aims at data-driven decision making, at all levels of the HEI.

An example of the use of "academic analytics" for the detection of students needing assistance is presented by Campbell (2007). Based solely on data gathered from a HEI's information systems, Campbell is able to relate students' grades with patterns of students' past academic record, intensity of use of the information system, and demographic characteristics. From these relations and from the digital track students leave, it is possible to detect those that need assistance and it is possible to trigger adequate actions.

A similar process that would fit a programme for dropout prevention and that would enable the detection of at-risk (of dropout) students is sketched in Figure 1.

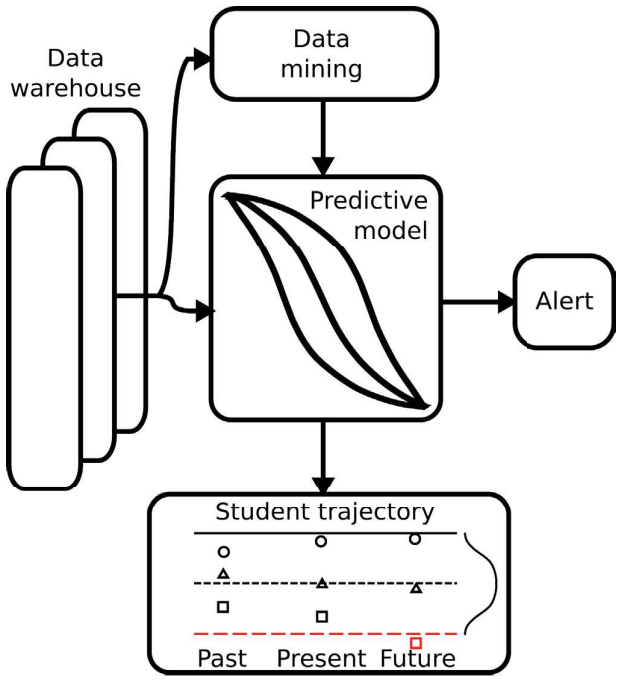

Figure 1. Process of at-risk student detection.

A data warehouse holding students academic and demographic records, and records of the students use of the different HEI's electronic platforms (at institutional, course and class levels), provides the necessary data. Based on scientific literature, variables included in the data

warehouse are associated with constructs relevant for the study of students' dropout. Statistical techniques can then be used to capture patterns of students' characteristics and behaviours associated with dropout. This constitutes the data mining stage.

Using the relations discovered during the data mining stage it is possible to detect at-risk (of dropout) students – the predictive modelling stage – and produce reports, highlighting students' "trajectories" and, alarms.

Goldstein (2005, p. 92) presents and discusses the key characteristics for successful academic analytics:
- Effective training;
- Administrative staff skilled at data analysis;
- Leadership committed to evidence-based decision making;
- Use of analytics to tailor recruiting strategies.

Campbell (2007) expands on the issue of leadership commitment, describing the important roles played by top HEIs management and all those managing enrolment, retention and the information system/course management systems.

Although not essential, it is believed that the integration of dropout prevention processes (such as the at-risk student detection process) and HEIs quality management systems is advantageous, contributing for a leadership committed to management based on facts.

Case study

Experience and results gathered from a small-scale study developed at IPS is used in this case study.

The sample consisted of a total of 293 students of a four years Technology and Industrial Management graduate course. The sample included all students enrolled between the academic years of 2007-2008 and 2010-2011. The majority of the students were adults (85%), male (82%), employed full-time (98%) and 59% of them had children. All students commuted to attend classes.

Data used in the study was gathered from the institutional information system. Considering the results reported by Metzner (1987) and Tharp (1998) it was decided to exclude environmental factors. After a preliminary analysis of the students' records it was concluded that the sample presented a high demographic homogeneity, therefore background variables such as gender, ethnicity and age were also excluded. A variable identical to GPA was considered: measure of student efficiency (described below). As suggested in Bean (1985) and Metzner (1987), this variable should "mediate" most of the influence of the academic factor on dropout.

The following variables were considered in the study:
- Measure of student persistence (N): number of enrolments (in the course);
- Measure of student efficiency (EF): the ratio between the number of approved modules and the cumulative number of attended modules (considering repetition).
- Measure of student background (B): a composite index that considers the student's performance (number of enrolments) at fundamental modules.

The measure of student persistence relates to student commitment. A higher number of enrolments imply more opportunities to socialise with peers and faculty and more opportunities to interact with the institutional environment. The measure of student efficiency relates to the

student cognitive ability, however, links to other factors such as student's background or even interaction with the institutional environment could be considered. The measure of student background is related to competences acquired in secondary school. This composite index considers the students' proficiency at first year, first trimester modules whose theoretical nature ask for competences that are distinct from the experiential competences common in adult students.

To study the relation between student dropout (dependent variable) and the variables above (independent variables) a logistic regression was performed. PASW Statistics 18 software package was used in this analysis.

Students that left the course with zero examination attendances (the majority with just one course enrolment) were removed from the sample. Outliers and influential cases were also removed. The working sample included 254 students.

After performing an initial logistic regression analysis it was concluded that the "background" variable had no statistically significant effect over the logit of the probability of dropping out ($\chi^2_{Wald}(1) = 0.133$; p=0.715). The model was adjusted without the "background" variable and the new logistic regression model proved statistically significant ($G^2(2) = 211.853$, p<0.001; $\chi^2_{H\!L}(8) = 6.043$; p=0.642; $R^2_S = 0.566$; $R^2_N = 0.803$; $R^2_{M\!F} = 0.683$).

From the logit coefficients of the logistical regression model relating dropout and the two statistically significant independent variables, an equation for the probability of dropout out was obtained. This equation was used to draw curves of predicted probability of dropout, as depicted in Figure 2.

When the regression model was used to classify the sample subjects, 90.9 % of the subjects were correctly classified (significantly above the percentage computed from the proportional classification criteria, 58.5%). The model sensitivity and specificity was also determined: 93.3% (12 false-negatives) and 85.5% (11 false-positives), respectively. These good results agree with those reported by Tharp (1998) that uses a similar sample (non-traditional students, urban commuter HEI) and concludes that "two particular variables, first semester hours [enrolled] and first semester grade point average, were significant in their ability to predict dropout."

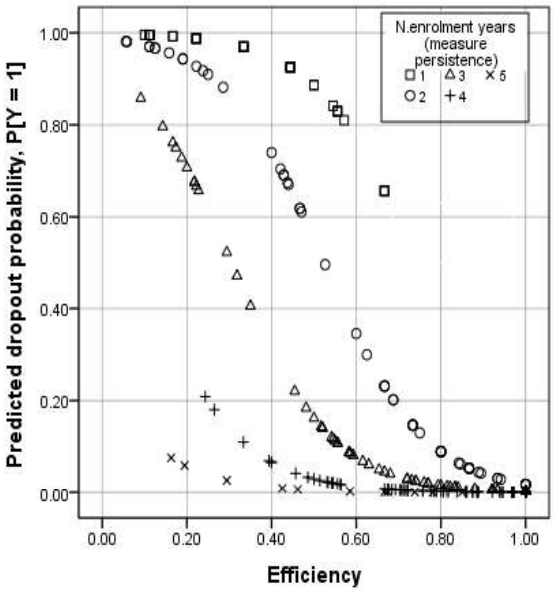

Figure 2. Probability of dropping out (Y = 1) as a function of student efficiency and a measure of student persistence (number of course enrolments, in years).

Figure 2 clearly shows that the probability of dropout lowers after the third enrolment. If a student enrols four or more years (plus and product sign in Figure 2), regardless of the efficiency, the probability of dropout will be quite low. The number of enrolments may lead inefficient students to believe they have come too far to turn back on the opportunity to graduate.

On the other side, if the student is at his second enrolment (circles, in Figure 2), efficiencies lower than 50% correspond to predicted probabilities of dropping out greater than 50%. Since the sample does not include freshman from the last academic year included in the study (2011-2012), all marks for one enrolment (squares, in Figure 2) are from freshman that dropped out (and attended at least one exam). The majority of these students fail on more than half the first year modules (efficiency < 0.5). According to Figure 2, predicted dropout probabilities above 50% occur for second and third year students with efficiencies below 50% and 30%, respectively.

To reduce the model sensitivity (reduce false negatives) 95% and 80% confidence intervals of the regression coefficients were used to define areas above and below the 50% predicted probability of dropout line, as shown in Figure 3. Combinations of efficiency and measure of persistence that fall in region A are associated with low dropout potential; region F is associated with high dropout potential.

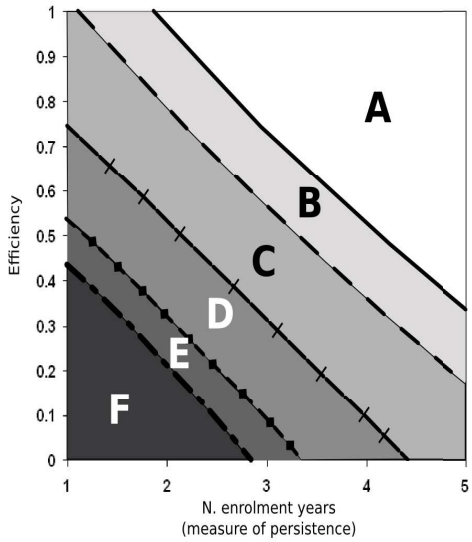

Figure 3. Regions of dropout potential: From high (region F) to low (region A) potential.

Figure 3 helps decision makers select the appropriate preventive actions and contributes to IPS' quality management team objective of promoting management based on facts. At present, actions following at-risk student detection fall outside the scope of IPS' quality management system.

Conclusions, limitations and future work

Dropout has important social and personal consequences. Without dropout monitoring and control, students life projects can be unnecessarily jeopardised and lead (specially for non-traditional students), to hasty decisions to quit higher education studies.

Although research confirms the influence psychological, sociological, economic, organisational and integrationalist factors (individually) have on students' dropout, from the standpoint of HEI's quality management – and regarding the teaching-learning macroprocess –, it is necessary to have techniques and methods that justify the need to intervene and inform decision making. Student dropout prevention is increasingly regarded a top priority; however, and in spite of decades of research, Boshier's critique remains appropriate: "It is not surprising that people interested in attracting non-participant segments of the general population or allaying dropout have difficulty translating research findings into administrative action. Unless there is some framework in which to order goals and understand processes, progress is ad hoc." (Boshier, 1973, p. 255)

The results presented in this paper show that there are good prospects of identifying at-risk (of dropout) students, using solely institutional information systems data. The presented case study concerns a course of non-traditional students with homogeneous demographic characteristics, further studies should clarify if institutional information systems' data remains appropriate for dropout prediction of heterogeneous student populations.

The research work done so far will be continued along two main lines of action: (i) The described case study will be extended, and the alert mechanism will gain visibility whenever at-risk students are detected (see Arnold, 2010); (ii) At-risk student detection will be extended to other IPS' courses. Bearing in mind that differences in student population characteristics may

require adjusting the relative importance of the factors influencing dropout, cluster analysis should be helpful within the data mining stage (recall Figure 1).

The quality management team also intends to close the dropout prevention Plan Do Check Act (PDCA) cycle and use results from the case study to support the need to design and implement specific actions aimed at (among others) at-risk students.

Finally, the research performed so far highlighted importance and need of flexible information technology platforms that enable the generation of databases with students demographic, academic and behavioural data, from the moment they first enrol to the moment they graduate and, ideally, that also include alumni data.

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