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Learning Analytics Dashboard Analysing First-Year Engineering Students

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Abstract. Nowadays, the higher education institutions experience the problem with the student drop-out. In response to this problem, universities started employing analytical dashboards and educational data mining methods such as machine learning, to detect students at risk of failing their studies. In this paper, we present interactive web-based Learning Analytics dashboard - *Analyst*, which has been successfully deployed at Faculty of Mechanical Engineering (FME), Czech Technical University in Prague. The dashboard provides academic teaching staff with the opportunity to analyse student-related data from various sources in multiple ways to identify those, who might have difficulties to complete their degree. For this purpose, multiple analytical dashboard views have been implemented; this includes summary statistic, study progression graph, and credit completion probabilities graph. In addition, users have the option to export all analysis related graphs for the future use. Using outcomes provided by the *Analyst*, the university successfully ran the interventions on the selected at-risk students and increased the retention rate in the first study year.

Keywords: analytical dashboard, educational data mining, student retention, data visualisation

1 Introduction

In recent years, universities face a problem of low retention of the students, especially in the first year of a university degree. In EU countries between 20% and 54% of students fail to complete their degree [1]. At the same time, higher education has experienced extensive growth of ICT based educational systems. These systems allow universities to collect a vast amount of data, which can be further analysed.

Learning Analytics (LA) seems to be one of the most promising fields regarding the potential of the student data analysis [2], [3]. One of the visualisation tools for displaying the results of the analysis is learning dashboards [4].

In our previous work [5], we have proposed a technique of discovering students at risk of failing in an academic year. These students can be offered an assisted help to increase their chances to finish the academic year with fewer problems.

In this paper, we present a learning dashboard which has been successfully deployed at the FME [5]. The application implements the approaches proposed in [5] and other analytical methodologies to support teachers while making decisions about learning processes.

2 Data

The FME uses a university system to export anonymised data. It contains personal and demographic data of the students along with their performance in courses. Additionally, for each performance record, there is a timestamp representing a date in which student has been given a grade. The date is vital information used in the analysis to calculate students' performance in an academic year [5].

The Analyst has been primarily developed for analysing of first-year students. Their data is available for four consecutive academic years (starting from 2013). In each year, approximately four hundred of students have registered to the degree, and about 15% of them failed in the first year. Students are divided into five performance groups for each academic year based on the criteria defined by the FME staff with respect to their teaching expertise.

3 Analyst

The dashboard has been implemented as a web application using Shiny technology¹ which is available for R language². The combination of Shiny and R creates an environment where a web application with R outputs can be easily created.

All graph components of the application are created using the ggplot2³ library and converted using the Plotly⁴ library to make all the graphs in the application interactive and provide an option to store them locally.



Fig. 1. The *Analyst* overview with data filter, navigation menu and study progress graph

¹ <http://shiny.rstudio.com>

² <https://www.R-project.org/>

³ <https://CRAN.R-project.org/package=ggplot2>

⁴ <http://ggplot2.org/>

The user interface of the application is divided into three parts (Fig. 1). Upper part provides a data filter that affects input data of all analytical tools. The user can filter by academic year, gender, a form of study and course type. It is also possible to analyse only first-year students. Whenever a change occurs in the filter, the dashboard recalculates the data and renders the results automatically. Left part contains a navigation menu for dashboard views and administration tools. Central part shows a content based on the selection in the menu. Administration tools are used to upload exported data, edit general course details or manage other parameters of the application. Following sections explain the dashboard views.

3.1 Study progress

The view contains a graph (central part of the Fig. 1.) of students divided into performance groups. Each group is represented by a line which shows average amount of credits achieved by students in the group for each week of the academic year. Moreover, dotted lines split the graph into several segments for better orientation in the academic year.

3.2 Study probabilities

The view consists of two components (Fig. 2). The first component allows the user to select a week of the academic year. The second component takes that week, filters data until the selected week and creates a graph where the horizontal axis shows numbers of credits and the vertical axis displays the probability of ending up in a specific performance group based on the number of credits earned up until the specified week. The probabilities are calculated using the Bayes' formula.

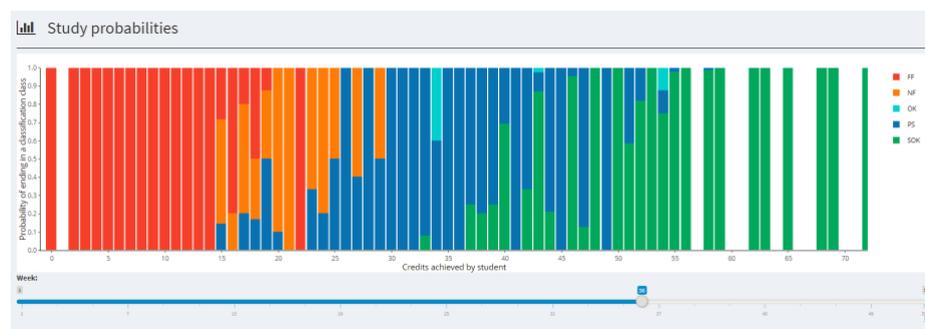


Fig. 2. Study probabilities graph

3.3 Summaries

The view (Fig. 3) gives an overview of the filtered data. In the top part, it shows a number of students in each performance group with the proportion of students to the

whole cohort. The histogram displays all courses in the selected dataset on horizontal axis and probability of achieving the corresponding mark on the vertical axis.

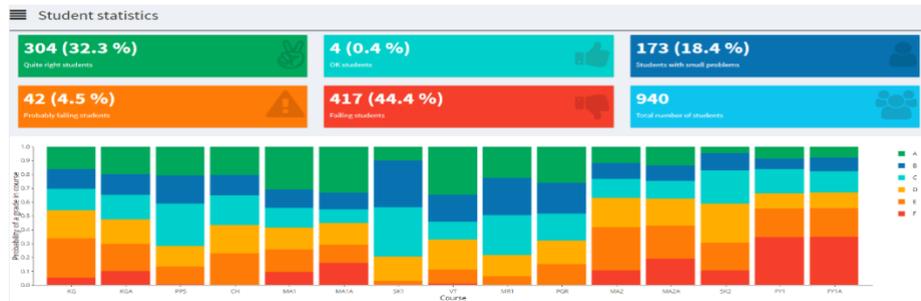


Fig. 3. Summaries view

4 Conclusion

We have developed a web application with multiple analytical tools which has been used by the FME staff to decrease the student dropout [5] successfully. In the future, the *Analyst* will be further extended to provide predictive modelling tools for estimation of students' outcomes.

5 Acknowledgement

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