Chapter 6
An Analysis of Student Performance in a Digital Electronics Design Course

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ABSTRACT

The main purpose of this research was to find relations between activities in Dees (Digital Electronics Education and Design Suite) and student performance in an undergraduate course of Digital Electronics. In our case of study, we used a dataset which contains examples of students using Dees toolkit. Firstly, we performed an analysis of the attributes of the dataset, to find correlations between student performance and activities developed during six sessions of the course. Secondly, we performed clustering using the algorithm k-means. Then, we concluded that, there is a relation between Dees activities performed by a student and student performance. This result opens the possibility of further analysis and perhaps the use of similar software toolkit in different courses of the Engineering curricula.

INTRODUCTION

Learning analytics has been used in educational settings to gain understanding of students, instructors and other stakeholders involved in the education process. As a result, Technology Enhanced Learning (TEL) has improved dramatically during the last decades. Currently, learning tools are more personalized and adaptive. This allows that the learning can be more optimized and therefore, learning is tailored to the need of each student (Chatti et al., 2012). We have classified the learning tools in three different categories. Firstly, we have the inquiry-guided learning tools. These tools focus in contexts where learners are to discover knowledge instead of passively memorizing concepts (Kruse & Pongsajapan, 2012). Secondly, we have the simulation-based environments. In these tools the data gathered from these educational environments has special features of student-performed actions. Thirdly, we have the data mining-based tools which find patterns in the data. These patterns can be used to improve the student learning. In fact, in recent years has been an interest in the use of Data Mining in the Education sector, in

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particular, among researchers in the field of Technology Enhanced Learning. The objective is to gain an understanding of the behaviour of learners by building models based in collected data (Siemens, 2012). To clarify to the reader, data mining techniques are used to extract patterns from raw data. Then, later these patterns are found in un-seen data.

Summing up, advances in information technology have made possible to store, manage and process big datasets. In particular, Data Mining has an important role by helping users to understand their data and find relevant patterns on the data. Data mining techniques aim at extracting high-level knowledge from raw data. However, the use of the Data Mining methods requires that we perform a selection of variables and model selection which are critical issues in the data mining process. Variable selection is useful to discard irrelevant inputs, leading to simpler models that are easier to interpret and that usually give better performance. Complex models may over-fit the data, losing the capability to generalize, while a model that is too simple could present limited learning capabilities. These issues have represented a problem for educators as they find difficult to use Data Mining tools.

Our case of study uses collected data from students attending an undergraduate course. The experiments presented in this paper were carried out using the student dataset which can be found in UCI machine Learning Repository (Lichman, 2013). The dataset contains data of a digital design course at the University of Genoa. The course assessment consisted of 6 sessions with the exception of one session (session 1) all the remaining sessions contributed to the final evaluation of the course. A hundred and fifteen students participated in evaluation. However, according to the grades only 62 were evaluated by the instructors. We selected the student dataset for two reasons a) the first reason is that we want to assess if the use of a suite like Dees could help instructors to understand student behaviour and then to improve students' performance and b) the second reason is that we have the dataset to our disposal (Lichman, 2013). The software used in our data mining experiments is WEKA, an open source, which contains several algorithms for Data Mining. Our main contribution is to perform an analysis on student performance and to identify the correlations between activities and students grades. In fact, to detect exercises which were difficult for mostly all students so forth. Therefore, we believe that research on student performance (finding relationships between activities and grades) could benefit in great deal the Technology Enhanced Learning (TEL). The correlations (between student performance and grades) presented in this paper are based in the analysis of the UCI dataset for a digital electronics design course. Another kind of assessment like, gaining skills by a student in a Computing MPhil program at the Open University can be found in Barroca et al. (Barroca et al., 2010).

The rest of the paper is organized as follows: firstly it provides an overview of related work. Secondly, it presents a brief description of the clustering algorithm, used in our solution to student performance analysis, namely k-means. Fourthly, it shows experiments carry out and finally, it gives our conclusions and future work.

RELATED WORK

Data mining algorithms were originally developed in the area of Machine Learning under the umbrella of the Artificial Intelligence field. Later, these algorithms were adopted by the Database community as powerful techniques for discovering patterns in raw data. The main applications of the database community were in the business sector (Shaw et al., 2001). Successful applications in business are for example, the use of data mining techniques in supermarkets data for directing publicity campaigns. However,