Improving Mathematical Competencies of Students Accessing to Higher Education from Vocational Training Modules

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ABSTRACT

This article describes the behavior and results obtained by two groups of engineering students from Vocational Training Modules who were recruited to use an on-line tool designed to improve their mathematical performance. Its effectiveness is evaluated using examinations results and an anonymous satisfaction questionnaire. The main difference between both groups is the presence or absence of deadlines for the recommended tasks. The results show that these initiatives are very welcome, and are also effective and capable of improving basic mathematical skills. The pattern of use shows strong persistence along the time, a significant use during non-working hours and a good correspondence between course participation and good performance in the final examinations. However, results, especially self-confidence and dropout rate, depend strongly on assigning due dates for doing the tasks. The use of deadlines arises as an important factor contributing to success.

Keywords: Case Study, Computer-Aided Instruction, Directed Self-Learning, Education, Higher Education, Mathematics, On-Line Tool, Time Control

INTRODUCTION AND OBJECTIVES

In recent years, engineering studies at the Spanish University are facing a situation that is impacting on the initial level of knowledge of our students: the presence in the classrooms of a growing group of students from Vocational Training Modules. This situation has arisen due to two main factors: first of all, after the recent changes in Spanish legislation about accessing to Higher Education, there are no limitations to the number of students from Vocational Training Modules that can access to degree studies. Moreover, the economic crisis scenario in Spain is leading people to improve their formation at

the University in order to find a better qualified job. Due to these circumstances, the number of students from Vocational Training Modules in our classroom has increased dramatically. Engineering studies like Technical Architecture has more than 40% of freshman coming from Vocational Training Modules; in the case of Computer Engineering this rate increases up to 60%.

These students from Vocational Training Modules have an important technical background which helps them to succeed in some technical subjects. Unfortunately, the initial level of knowledge in Physics or Mathematics of these students is very poor, especially compared with their partners from Secondary and High School. This lack of knowledge is particularly relevant in engineering studies. Many authors and institutions from engineering and educational fields have described the importance of the mathematical knowledge in Engineering Education, mainly in the first courses (Kent & Noss, 2003; Mustoe & Lawson, 2002). The mathematical knowledge seems to be the basis for the formation of the future engineers, and the mathematical level at the entrance at the University, the so-called "*core zero*", (European Society for Engineering Education, 2013) is a good indicator of the future performance of these students in engineering studies. There is an increasing group of studies about the level of mathematical knowledge of engineering studies in different countries (Lawson, 2003; Mustoe, 2002; Ní Fhloinn & Carr, 2010; Kurz, 2010; Institute of Physics, 2011; Bowen, Prior, Lloyd, Thomas & Newman-Ford, 2007; Luk, 2005; Carr, Bowe & Ní Fhloinn, 2013, Perkin & Bamforth, 2011).

This situation has been recently confirmed by other authors in Spain after administering an initial test to measure the knowledge of basic mathematics of first-year students enrolled in various engineering degrees and comparing the educational backgrounds from which those students had accessed to these degrees. This initial test, which contains basic mathematical questions and some elemental mathematical operations, has been taken during various academic courses by students from different engineering studies at the Higher Polytechnic School of Zamora, which belongs to the University of Salamanca (Spain). Some results of these studies for the academic year 2010-2011, including a detailed analysis of the main differences between High School students' performance and Vocational Training Modules students' performance, have been shown in Nieto and Ramos (2012).

As our analysis reveals, the students from Vocational Training Modules always show a very poor performance in all the test items, even in the easiest ones. This poor performance is consistently worse than that of the students from Secondary and High School. These results are consistent along the whole test and for all the 25 items considered. Furthermore, the main problem with these students from Vocational Training Modules is the lack of substantial improvement that they show along the course. When we have made a post-test at the end of the course using the same items, the progress of these students proves to be consistently lower than the progress of the students from Secondary or High School. Another relevant fact resulting from this analysis is the high drop-out rate of students coming from Vocational Training Modules. During the academic year 2011-2012, 25% of these students did not take the final exam of mathematics.

For this reason, we decided to find ways of improving the mathematical knowledge of this group of students when they access to engineering studies at the university. Due to the amount of academic work that the university students must carry out during the semester and their different timetables, the design of any academic support program excludes face to face sessions. We, therefore, opted for an on-line tool which enabled students to decide where and when access to the lessons and activities at their own pace. This would have the effect of maximizing their learning outcomes and their participation while minimizing their effort. Of course, the educational effectiveness of ICTs depends on how they are used and for what purpose (Tinio, 2003), but, in the context of