ASSESSMENT TOOL FOR MAXIMISING PERFORMANCE IN HETEROGENEOUS PROFILES FOR BOLOGNA HIGHER EDUCATION DIPLOMA SUPPLEMENT STUDIES

Roberto Llorente, Maria Morant and Fernando J. Garrigos-Simon

Universitat Politècnica de València (SPAIN)
rllorent@dcom.upv.es, mmorant@ntc.upv.es, fgarrigos@doe.upv.es

Abstract

This paper proposes an assessment tool for the evaluation of students obtaining the "diploma supplement" for Bologna High Education Bachelor Degree. Specifically the tool has been introduced in 2012 for the diploma supplement of Telecommunication Engineering Degree at the *Escola Politècnica Superior de Gandia*, *Universitat Politècnica de València,* in a mandatory subject dealing with television and video systems. The student profiles are assessed considering different variables like the university they come from, how many years have passed since they began their studies and if they have coursed subjects about related topics. The assessment also evaluates if the student meets the proposed schedule following the order of the laboratory lessons and relates it with the mark obtained in the tests done for the laboratory contents. Other concepts are analyzed in the study, such as if the student assists regularly to the theory lessons, if the students are exempt from attending to the lessons because they are working, and if they attend to the professional visit to a local television broadcasting site. The assessment tool includes the evaluation of the tests for different difficulty levels following Bloom's taxonomy and taking into account the different student profiles of the diploma supplement course. This assessment of the tests results is useful to identify the strengths and weaknesses in the student learning observed in the different contents of the subject. Results indicate that student's achievements are directly related with the attendance to the lectures and seminars in the classroom and to the laboratory lessons. We have not founded difficulties in bringing together students from different universities and with different ages. No relation is observed either with how long passed since the student started its previous Diploma Degree studies. The work confirms the suitability of the Bologna diploma supplement course for the Telecommunication professionals with previous Engineering Degrees.

Keywords: Graduate education, diploma supplement, innovation, difficulty level

1 INTRODUCTION

Traditionally, Spain had two different types of high-education degrees: the 3-year "Diplomatura" or Technical engineering degrees leading to a medium-level technical profession such as medium-level Engineering, nursing or school teaching; and the 5-year "Licenciatura" or "Engineering" giving access to higher-level professions or academic disciplines like Physics, Chemistry, History, Medicine (6-years), higher Engineering and Economics. These higher-level degrees were opening the path to the doctorate. The Bologna process created the European Higher Education Area and established a system of credits for comparable degrees (van der Wende, 2000) called the European Credit Transfer and Accumulation System (ECTS). One academic year corresponds to 60 ECTS credits that are equivalent to 1500-1800 hours of study (Hedberg, 2003).

With the new Bologna system, in Spain the first cycle of higher education studies comprises the Bachelor degree based in 4-year studies with typically 180-240 ECTS credits. The second cycle is a 2-year Master degree with typically 90-120 ECTS in order to access to the Doctorate.

Many European Universities prepared a "diploma supplement" available to the students with previous medium-level diploma degrees for obtaining a transcript to Bologna Bachelor Degree (McGrath, 2000). In the *Universitat Politècnica de València*, the diploma supplement to the Bologna Bachelor Degree in Telecommunication comprises 60 ECTS. This high education course presents different characteristics compared with conventional Bachelor Degrees, as the students requesting the diploma supplement may come from different universities having different profiles. For this reason, in this paper we propose an assessment method for diploma supplement subjects.

Llorente *et al.* (2007) proposed an evaluation method for laboratory lessons, developing tests consisting in five questions covering the subjects studied in the laboratory session in the last 15 min of every laboratory session. This approach was extended introducing interactive seminars and the evaluation of the alumni knowledge acquisition based on deep data-mining techniques (Llorente and Morant, 2009). In this paper, we modify this data-mining tool for the assessment of diploma supplement in Engineering studies considering the different profiles of students and including different difficulty levels. This tool has been introduced in 2012 for the diploma supplement of Telecommunication Engineering Degree at the *Escola Politècnica Superior de Gandia* (EPSG), *Universitat Politècnica de València* (UPV), in a mandatory subject dealing with television and video systems (UPV code 11305). The innovation of this work includes the classification of the questions of the different curricular units in three difficulty levels following the Bloom taxonomy. Bloom defined a taxonomy of learning with hierarchical structure representing different levels of learning skills that range from basic learning objectives (e.g. knowledge of content) to higher-order learning (e.g. synthesis, evaluation, and creativity). In (Anderson *et al.* 2001), Bloom's taxonomy was revised and classified in six levels from basic to advanced levels as shown in Fig. 1(a): knowledge, understand, apply, analyse, evaluate and create. In our case the questions are classified in three difficulty levels (1: basic knowledge, 2: understanding and 3: application) as depicted in Fig. 1(b) in order to obtain a profundity difficulty map of the cognitive learning of the students.

The assessment of the results including this difficulty levels is useful to identify the strengths and weaknesses in the learning process for the different contents of the subject. The identification of these strengths helps the faculty to identify the activities and assignments that produce high-quality learning. When preparing the course, these activities should be preserved. On the other side, knowing about the areas where students encounter problems can help the professor to think about other options that might address these topics and improve the learning process on the subject.

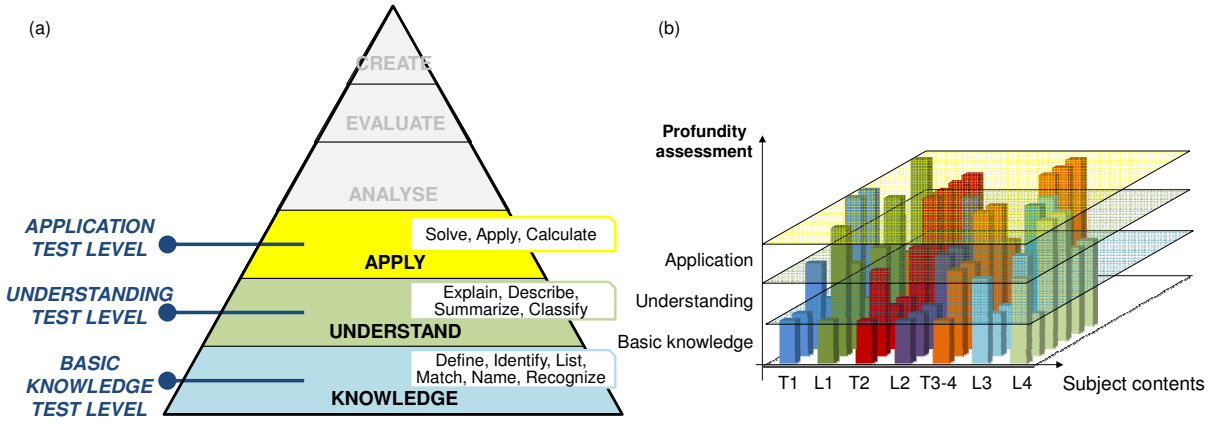

Fig. 1. (a) Revised Bloom's taxonomy (Anderson *et al.* 2001) and (b) proposed difficulty level of the questions,

This paper is structured as follows: in Section 2, the evaluation of the different profiles of the students of the diploma supplement is done for different variables like the university they come from, how many years have passed since they began their studies and if they have coursed subjects about related topics. Next, in Section 3, the evaluation method is presented including the assessment of theory and laboratory lessons with questions with different difficulty levels. Finally, Section 4 shows the results of this work and Section 5 summarizes the main conclusions.

2 STUDENT PROFILES

The *Universitat Politècnica de València* is offering the possibility of having a diploma supplement to the Bologna Bachelor Degree in Telecommunication to the students who have finished the previous medium-level three-year Engineering Degree in Telecommunication. This diploma supplement course comprises 60 ECTS with subjects covering different topics in order to cover the curricula of actual Bologna Bachelor Telecommunication Degree: digital signal processing, communication, electronics and telematics. As it was commented before, the alumni attending the diploma supplement course may come from different universities and have finished their previous diploma in different academic years. This turns out in a heterogeneous classroom with students of different ages, different curricula and in consequence different previous knowledge to given topics.

In order to assess the different student profiles, in the academic year 2012/2013 several variables have been proposed and evaluated in a classroom of 40 students of a diploma supplement subject dealing with television and video systems ("*Sistemas de Televisión y Video*", UPV code 11305). The following variables have been considered and evaluated in relation with the marks obtained by the students.

- **Variable #1. Attendance to lectures:** Several studies in the literature (Clifford, 1999) indicate that the student attendance to the lectures is positively and significantly related to their achievement performance (Lamdina, 1996). For this reason, the attendance of the students to the lessons covering theoretical concepts and seminars in the classroom were traced by the professors. The attendance of the laboratory lessons of the subject is mandatory as a short test is presented to the students at the end of the session. Moreover, in the new Bologna degrees, the students who are working at the same time of their studies can ask for an exemption from attending the lectures. If the student is exempt from attending the lectures will be another variable under study.
- **Variable #2. Follow the schedule of laboratory sessions:** The subject curricula is classified by blocks covering different topics and the laboratory sessions are planned following an schedule to cover the theory concept before practicing in the laboratory. However, in the last years it has been observed that some students do not follow the schedule of laboratory sessions and retake the sessions they have not attended at the end of the course.
- **Variable #3. Retake a laboratory session:** The impact of following the schedule on the final mark is evaluated also considering if the student retakes any of the laboratory sessions at the end of the course.
- **Variable #4. Attendance to the professional visit:** At the end of the semester it is scheduled a professional visit to a real TV broadcasting site. The attendance to this activity is also evaluated in the study.
- **Variable #5. University the student comes from:** As the students coursing the supplement diploma may come from different universities, it will be also considered.
- **Variable #6. Previous knowledge of subjects dealing with similar topics:** Another concept to take into account is to track the previous knowledge of the subject. In this case we have considered if the student has achieved before other subjects dealing with similar topics, such as subjects Audio and video broadcasting ("*Difusión de audio y video*", UPV code 6507) and digital systems for television ("*Sistemas digitales de televisión y video*", UPV code 6445).
- **Variable #7. How long has passed since the student started the diploma degree studies:** Finally, we also evaluate the impact of the different experience of the students on the field. As the diploma supplement course is oriented to students who have finished their medium-level Telecommunication Engineering Degree studies, we will find out that some students finished their career long time ago and some others in the last years. In this case it is interesting to the professors to evaluate if this difference has an impact on the learning process

3 ASSESSMENT OF THE RESULTS

The subject under study in the diploma supplement deals with television and video systems ("*Sistemas de Televisión y Video*", UPV code 11305) and comprises theory lessons, group seminars, laboratory sessions and a professional visit to a local television broadcasting site.

The evaluation of the theory is done with different tests in each of the 4 curricula blocks. The laboratory lessons are evaluated with short tests at the end of the session. The difficulty level of each question is identified in the test following the Bloom taxonomy as was depicted Fig. 1

The curricula contents of the subject of systems for TV and video (STTV) are classified in four units dealing with introduction to analog TV and basic concepts of digital TV, digital video encoding, MPEG standard and video quality. Each curricula unit (U) includes in the scheduling a laboratory session for testing different contents explained in the classroom. As it was introduced before, the evaluation is done with test with different questions for the theory contents (T) and for the laboratory sessions (L). The different questions of the theory tests (T1-T4) and laboratory sessions (L1-L4) are classified per difficulty level as shown in Fig. 1 (b).

Our analysis comprises Pearson correlation coefficients. The tool of the “Pearson Correlation” provides us with the size and direction of the hypothetical line that can be drawn through the data. Additionally, the “Significance” indicates the probability that the line is due to chance. Specifically, this “Significance” represents a test of whether the line is different from a flat line (e.g. a flat line would be represented by a Pearson correlation = 0). Table 1 summarizes the correlation results obtained for the variables defined in Section 2.

According to our data, the final score obtained by the students is directly related with the attendance in both the lectures in the classroom and in the laboratory lessons. It was also observed that even in the cases of students with exception from attendance because they are working at the same time, those who made the effort to attend the maximum possible number of classes achieved better marks.

It can be observed from the results that the mark obtained by the students in the laboratory tests is related with retaking any of the laboratory sessions. In some cases it was observed that students retook a laboratory session for better understanding the contents.

We have not encountered difficulties in bringing together students from different universities. This was also pointed out in Canada universities (Joós *et al*. 2004). In addition, it is observed no relation between the final achievements and how long passed since the student started its diploma degree study. This confirms the suitability of the Bologna diploma supplement course for the Telecommunication professionals with previous Engineering Degrees.

Table 1. Variable correlations

		1	2	3	4	5	6	7	Lab Mark	Final Mark
1	Pearson correlation	1.000	0.084	0.022	0.185	0.135	0.221	-0.221	0.168	0.372*
	Sig. bilateral	0.000	0.604	0.892	0.252	0.404	0.170	0.210	0.300	0.018
2	Pearson correlation	0.084	1.000	-0.711**	0.361*	0.017	0.164	-0.183	-0.311	0.002
	Sig. bilateral	0.404	0.000	0.000	0.022	0.919	0.313	0.279	0.051	0.992
3	Pearson correlation	0.022	-0.711**	1.000	-0.282	-0.086	0.000	0.306	0.338*	-0.088
	Sig. bilateral	0.892	0.000	0.000	0.078	0.597	1.000	0.066	0.033	0.591
4	Pearson correlation	0.185	0.361*	-0.282	1.000	0.145	0.089	0.016	0.091	-0.083
	Sig. bilateral	0.252	0.022	0.078	0.000	0.370	0.585	0.926	0.578	0.610
5	Pearson correlation	0.135	0.017	-0.086	0.145	1.000	0.102	-0.215	0.157	-0.093
	Sig. bilateral	0.404	0.919	0.597	0.370	0.000	0.531	0.200	0.335	0.566
6	Pearson correlation	0.221	0.164	0.000	0.089	0.102	1.000	-0.089	0.044	0.033
	Sig. bilateral	0.170	0.313	1.000	0.585	0.531	0.000	0.601	0.785	0.841
7	Pearson correlation	-0.211	-0.183	0.306	0.016	-0.215	-0.089	1.000	0.098	-0.311
	Sig. bilateral	0.210	0.279	0.066	0.926	0.200	0.601	0.000	0.563	0.061
Lab mark	Pearson correlation	0.168	-0.311	0.338*	0.091	0.157	0.044	0.098	1.000	0.376*
	Sig. bilateral	0.300	0.051	0.333	0.578	0.335	0.785	0.563	0.000	0.017
Final mark	Pearson correlation	0.372*	0.002	-0.088	-0.083	-0.093	0.033	-0.311	0.376*	1.000
	Sig. bilateral	0.018	0.992	0.591	0.610	0.566	0.841	0.061	0.017	0.000

* Significant correlation for level 0.01 (bilateral)
** Significant correlation for level 0.05 (bilateral)

The analysis of the relation of the difficulty level is done for 40 students of the STTV subject (UPV code 11305) of the *Escola Politècnica Superior de Gandia* in the academic year 2012/2013. Fig. 2 shows the global view of the 40 students' achievements in relation with the curricula unit and the difficulty level in the Bloom Taxonomy. It can be observed that the students comprehend better the basic knowledge questions. This is clearly seen at the beginning of the course as it can be observed in Fig. 2(a) that the first curricula unit (U1) obtained the highest percentage for basic knowledge questions. The achievement percentages of the understanding and application levels increase considerably in the following curricula units compared with the first unit (U1) that was the introduction of the subject. Also it can be observed in Fig. 2 that the evolution of the alumni along the different units increase the profundity learning. At the last unit (U4) the students achieve the 100% of basic questions and increase their understanding and application knowledge. The understanding level questions are always above a 75%, giving a maximum of 86% in the third curricula unit (U3) dealing with MPEG encoding. In the case of application questions, a maximum of 88% was observed in unit U2 covering digital television contents. These contents were further reviewed during the professional visit to a digital TV broadcasting site so achieving deeper learning.

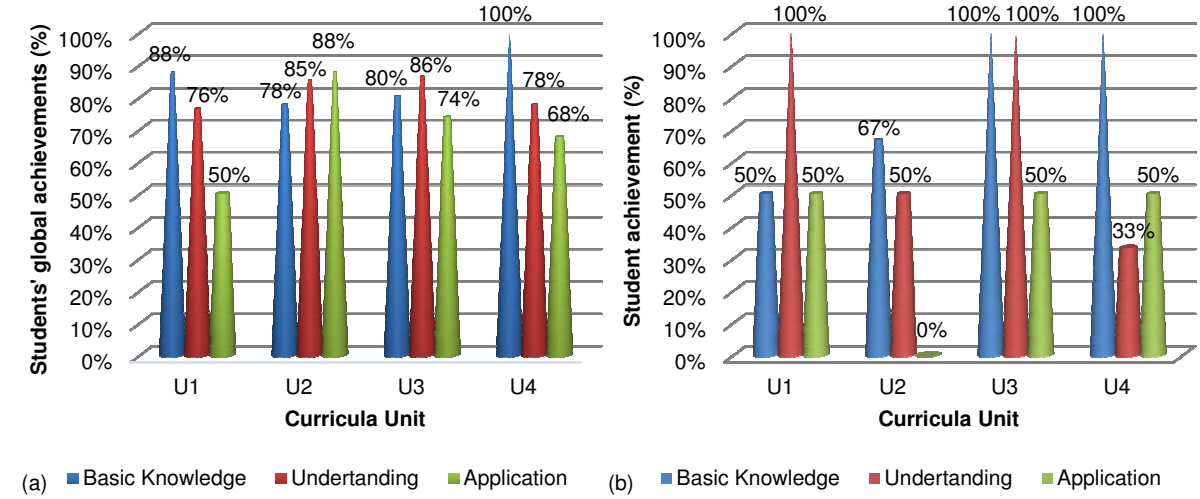

Fig. 2. Achievements based on the difficulty level for (a) 40 students global view, and (b) single student example

Fig. 2(b) shows a case example of a single student. In this case the student missed some lectures at the end of the course and the second laboratory lesson. This example was chosen as it represents clearly the impact of not attending the lectures, as it can be observed that the achievements obtained in U4 are clearly worse than the obtained in previous units. In addition, it can be observed that in the second unit (U2), as the student did not attended the laboratory lesson when it was scheduled, it did not achieved any of the high-level application contents. This highlights the importance of the laboratory practical lessons in order to achieve deeper learning and also the importance of a good scheduling. Fig. 3 shows the learning map representation of the different contents per difficulty level. The learning map shown in Fig. 3(b) corresponds to the same student as evaluated in Fig. 2(b).

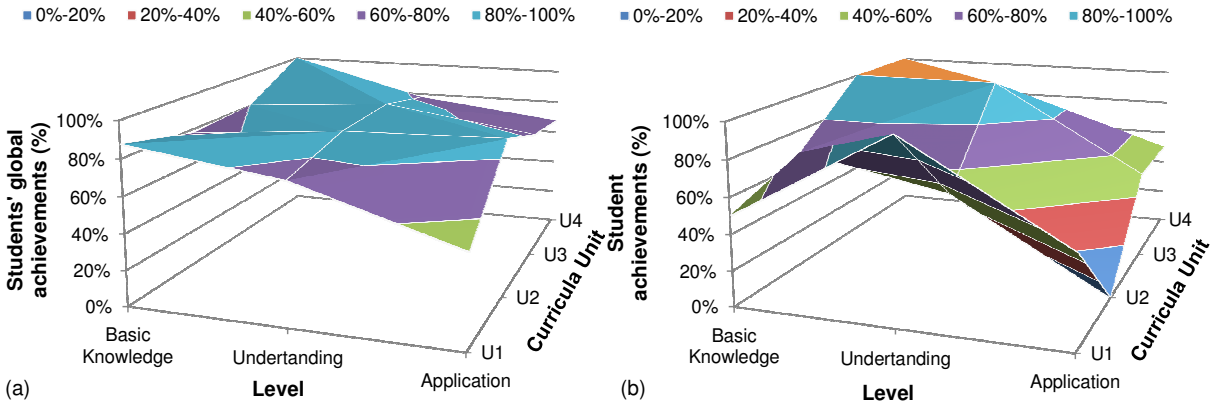

Fig. 3.Profundity learning map based on the difficulty level for (a) 40 students global view, and (b) single student example

With these profundity maps it can be better seen the contents that have been covered deeper or just superficially. It is confirmed that the first curricula unit achieved more basic knowledge contents and less application. This profundity behaviour can be observed better in Fig. 2(b) were a hole can be observed in the application level of U2 due to missing the laboratory lesson corresponding to that unit.

4 CONCLUSION

This paper proposes and analyses an assessment tool for the evaluation of students obtaining the diploma supplement for Bologna High Education Bachelor Degree. This tool has been introduced in 2012 for the Bologna diploma supplement of Telecommunication Engineering Degree at the *Escola Politècnica Superior de Gandia*, *Universitat Politècnica de València,* in a mandatory subject dealing with television and video systems. The different student profiles were assessed considering different variables like the university they come from, how many years have passed since they began their studies and if they have coursed other subjects about related topics. The assessment also considers if the student assists regularly to the theory and seminar lessons, if the students are exempt from attending to the lessons because they are working, and if they attend to the professional visit to a local television broadcasting site.

From the statistical analysis we observed that the final score was directly related with the attendance to the lectures in the classroom and in the laboratory lessons. It was also observed in the cases of students with exception from attendance, the students who made an extra effort to attend the maximum possible number of classes achieved better results. The achievements obtained by the students in the laboratory tests are related with if they retook any of the laboratory sessions. In some cases it was observed that students retook a laboratory session for better understanding the contents.

We have not encountered difficulties in bringing together students from different universities and with different ages. No relation is observed with how long passed since the student started its diploma degree study. This confirms the suitability of the Bologna diploma supplement course for the Telecommunication professionals with previous Engineering Degrees. Further investigation on this topic will include new technologies for the on-line evaluation of the students including the student profiles and the difficulty levels proposed in this paper.

References

Anderson, L.W.; Krathwohl, D.R.; Bloom, B.S. (2001), *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*, Ed. Longman, New York.

Clifford, A. (1999), *Answers in the Tool Box. Academic Intensity, Attendance Patterns, and Bachelor's Degree Attainment*, Ed. Education Publications Center, U.S.

Hedberg, T. (2003), "The impact of the Bologna Declaration on European engineering education", *European Journal of Engineering Education*, Vol. 8, Issue 1, pp. 1-6.

Joós, G.; Marceau, R.J.; Scott, G. and Péloquin, D. (2004), "An innovative industry-university partnership to enhance university training and industry recruiting in power engineering", *IEEE Transactions on Power Systems*, Vol. 19, Issue: 1, pp. 24 – 30.

Lamdina, D. J. (1996), "Evidence of Student Attendance as an Independent Variable in Education Production Functions", *The Journal of Educational Research,* Vol. 89, Issue 3.

Llorente, R.; Morant M. (2009), "Accurate Knowledge Evaluation by Deep Data-mining in Telecommunication Engineering Studies", in 20 Annual Conference Innovation in Education for Electrical and Information Engineering (EIE), EAEEIE2009, ISBN: 978-84-8363-428-8.

Llorente, R.; Morant, M.; Alba, J. (2007), "Novel class-level self-adaptive on-line evaluation technique in Telecommunications engineering studies", in INTED2007 Proceedings, Ed. IATED, ISBN: 84-611-4517-8.

McGrath, D. (2000), "The Bologna declaration and engineering education in Europe", Institution of Engineers in Ireland available at mie.uth.gr

Stany, J.C. (2012), "Assessment of Student Learning: Introduction to Bloom's Taxonomy" in CCR workshop of University of West Florida.

Van der Wende, M. C. (2000), "The Bologna Declaration: Enhancing the Transparency and Competitiveness of European Higher Education", *Higher Education in Europe*, Vol. 25(3), pp. 305-310.