How to Measure Students' Individual Performance in Active-Learning Environments: A Case-Study

Carla Pinto[1], Susana Nicola[2], Jorge Mendonça[3]

School of Engineering, Polytechnic of Porto – Centre for Mathematics, University of Porto, Portugal[1]
School of Engineering, Polytechnic of Porto – Interdisciplinary Research Center [ISRC], Portugal[2]
School of Engineering, Polytechnic of Porto – Interdisciplinary Research Center [ISRC], Portugal[3]

Abstract

Facing enormous global challenges, we are now in the transforming age where shifts are expected in the way we learn, live and work [1]. This puts a high emphasis on education, creating an increasing demand for new ways of teaching. Students are no longer merely passive vessels of knowledge but are asked to actively engage in their learning process. They participate more, applying, analyzing, evaluating and criticizing information, instead of just memorizing it. Moreover, a special focus is also put on the development of soft skills, namely social skills, communication skills, career attributes, emotional and social intelligence. All of these are traits of active-learning methodologies, which were popularized by Bonwell and Eison in 1991.

These new teaching frameworks have started the debate on how to effectively assess students' performance individually and in group [5][6]. In this work, we provide a case-studies assessment tool for a curricular unit (CU) of a Bachelor Engineering Degree of the School of Engineering of the Polytechnic of Porto. In this CU, called System's Lab, students work in groups to develop innovative products, recurring to multidisciplinary approaches in the area of business. Students have to propose an idea, construct a business model, a financial plan, develop an application and present their products in a Pitch format. Students are evaluated by four professors from different backgrounds, Mathematics, Electrical Engineering and Management, and by their peers. Students' assessment is then achieved by grading several parameters, from communication and time management, presentation quality, business model, demo, logbooks, and exams.

This new assessment tool, Tool to Assess students in Lab Courses (TALC), has provided a way to evaluate students which has, in our opinion, reduced the bias, without increasingly the burden in evaluation.

Keywords: *Active-learning methods; assessment; peer-evaluation*

1. Introduction

As work-environments are becoming more and more competitive, organizations focusing on process, performance and motivation of their employees will prevail. In this regard, constant learning is essential to sustain these organizations' competitiveness. Nevertheless, past approaches to learn, based on passive techniques are outdated and are slowly giving the way to more active learning methods.

In the *good* old days, our students had to attend big classes, where knowledge was delivered to them by the teacher, and they merely listened, took notes, and memorized. Nowadays, students have a myriad of options to learn. Knowledge is at a distance of a simple click, students only need to have WIFI and a computer, or tablet, or a mobile phone. They can learn at home, at school, or at a coffee shop. Students' skills, learning environment, and needs impel adjustments in what is the role of the teacher. Technology is undoubtedly helping to reshape our lives. And it is not only from the way we learn or communicate, but also the way we teach. All is changing and is changing fast. Thus, we must think on how to adjust and adapt courses' contents, and ways to deliver them, and how to create motivating learning frameworks to present these students with the best as possible learning experiences [1], [2].

The challenge for us teachers is twofold. On one hand, we need to adapt our courses to the Active learning (AL) methods, and on the other hand, we have to reach our highly dependent on tech students. The learning environment of today was not the one of yesterday and will not be tomorrow's.

AL has been presented in the 90's as a learner-centered concept, in which the responsibility of learning is shifted from the teacher to the student. AL intends to break the apprentice-master passive

learner strategy, where the student listens and memorizes. With AL the teacher is seen as a knowledge facilitator, whose task is to guide students in their learning process, using different AL training activities. Research shows a deluge of benefits from the application of AL, from increased content knowledge, critical-thinking, communication, collaboration, problem-solving, creative thinking, and, most importantly, motivation [3][4].

As a synopsis, promoting the development of AL learning environments starts with a detailed planning from a conscientious teacher, but should be the responsibility of the entire community, from the academy, to stakeholders, to the CEOs of the companies which will employ our students in a near future.

Assessment techniques, tools or instructions for gauging, quantifying or estimate the learning outcomes of students is a big issue, concerning the feedback and the continuous improvement of the learning process. Many frameworks and methodologies had been developed in order to avoid bias when assessing students' team-work and soft skills. The authors Glyn *et al*, in 2011 [5], applied three initiatives with "future-learning" oriented. Based on the literature review and on the best practices of active learning technique that had been applied in several courses, Eddy, S. L. [6] *et al* developed the Practical Observation Rubric To Assess Active Learning (PORTAA), which measures instructors' alignment with these practices as well as give "the research-supported elements of best practices for instructor implementation of active learning in the classroom". The authors Conde, M. Á., Hernández-García *et al* [7], applied and evaluated a methodology called Comprehensive Training Model of the teamwork Competence (CTMC) in 4 courses of Bachelor of Science and Master Science degree on Computer Science.

The outline of the paper is as follows. In Section 2, we describe the proposed assessment tool, TALC. In Section 3, we analyse statistically the results from the implementation of TALC. We conclude this work in Section 4.

2. Evaluation tool to assess students in lab courses (TALC).

There is a huge need to assess students with different methods to develop and prepare students as independent learners to be successful in their higher education programs and in their professional lives after finished their courses. In the evaluation tool (figure 1) we used direct and indirect methods. In the direct methods we apply exams on specifics areas of electrotechnology, informatics and management and were done several presentations along the course as wells a final report (logbooks). In the indirect methods we use several questionnaires along the course, and interviews about their opinion of the methodology applied in the course.

Figure 1 – Evaluation Tool - TALC

Ideal assessment tools identify the most important expected learning outcomes, both inside and outside of the subject field. With regard to the growing interest in developing tools to assess the twenty first century skills [9], we present a Tool to Assess students in Lab Courses (TALC). The aim was to have several parameters to assess students, eliminating the bias that sometimes occurs in the traditionally way. TALC was registered in an Excel worksheet according to 5 dimensions: oral presentation, DEMO presentation, logbooks, exams (electrotechnology, informatics and management) and self and peer evaluation. These dimensions had a weight of 40% for oral presentation, 20% for DEMO, 20% for the logbooks, 10% for the exams and 10% self/peer evaluation. The first dimension, oral presentation, was divided in 3 sub-dimensions, communication and time management, business

model and presentation quality, each of them graded 1 to 4. Figure 2 depicts the explanation for all the levels for communication and time management. To score 4, the students need to use a clear voice and corret, precise pronunciation of the terms, and dexterity in the capacity of communicate with the audience,as well as a proper duration of a Pitch Format (5 minutes of presentation).

	Very Good	Good	Satisfatory	Needs Improvement
	4 - excellent	3- good	2- fair	1- poor
Communication & Time Management	Student uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation. The presentation was of the proper duration.	Student's voice is clear. Student pronounces most words correctly. Most audience members can hear presentation. The presentation was of the proper duration.	Student's voice is low. Student incorrectly pronounces terms. Audience members have difficulty hearing presentation and/or the presentation was somewhat short or somewhat long.	Student mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear and/or the presentation was too brief or too long.

Figure 2 – Parameters of the Sub-Dimension – Communication and Time Management

	Very Good	Good	Satisfatory	Needs Improvement
	4 - excellent	3- good	2- fair	1- poor
Presentation Quality	Student shows enthusiasm and presents information in logical, interesting sequence which engages the audience. Student demonstrates full knowledge (more than required) and answers all questions with explanations and elaboration.	Student presents information in logical sequence which audience can follow. Student is at ease with information and gives expected answers to all questions, but fails to elaborate.	Audience has difficulty following presentation because student jumps around. Student is uncomfortable with information and is able to answer only rudimentary questions.	Delivery not smooth and audience attention lost because there is no sequence of information.Student does not have grasp of information; student cannot answer questions about subject.

Figure 3 – Parameters of the Sub-Dimension – Presentation Quality

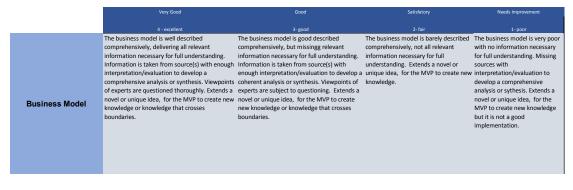|	Very Good	Good	Satisfatory	Needs Improvement
	4 - excellent	3- good	2- fair	1- poor
Business Model	The business model is well described comprehensively, delivering all relevant information necessary for full understanding. Information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis. Viewpoints of experts are questioned thoroughly. Extends a novel or unique idea, for the MVP to create new knowledge or knowledge that crosses boundaries.	The business model is good described comprehensively, but missing relevant information necessary for full understanding. Information is taken from source(s) with enough interpretation/evaluation to develop a coherent analysis or synthesis. Viewpoints of experts are subject to questioning. Extends a novel or unique idea, for the MVP to create new knowledge or knowledge that crosses boundaries.	The business model is barely described comprehensively, not all relevant information necessary for full understanding. Extends a novel or unique idea, for the MVP to create new knowledge.	The business model is very poor with no information necessary for full understanding. Missing sources with interpretation/evaluation to develop a comprehensive analysis or sythesis. Extends a novel or unique idea, for the MVP to create new knowledge but it is not a good implementation.

Figure 4 – Parameters of the Sub-Dimension – Business Model

The other four dimensions were scored 1 to 4, as well. The DEMOS evaluation was carried out by the actors responsible for the respective areas. In self- assessment, students judge their own work, while in peer assessment they judge the work of their peers [5]. The TALC provided the self and peer evaluation in order to involve, to turn students more independent and responsible for their work, and to extent students assertiveness about their work as well as improving their thinking processes.

4. Statistical analysis

The statistical analysis of evaluation tool TALC applied to 39 students was done taking account two groups of variables. The first group composed by 5 categorical variables: Communication and management, Business model, Presentation quality, DEMO and Logbook. The second group consists of two continuous variables: Peers evaluation and Exams. We checked the relationship between pairs of variables of the first group. For this purpose we computed the correlations (Table 1) between variables. We observed that Communication and management has a significant correlation with

Presentation Quality and DEMO. Presentation quality has a significant correlation with DEMO and Logbook. The component business model has only one significant correlation with Logbook. It seems that a good performance in Presentation quality is associated to a good performance in DEMO, Logbook and Communication and Management. The Business model is associated with a good performance in Logbook.

	Comnunication and Management	Business model	Presentation quality	DEMO	Logbook
Comnunication and Management		-0.132 (0.422)	0.365* (0.022)	0.674** (0.000)	-0.073 (0.659)
Business model			0.177 (0.280)	-0.122 (0.458)	0.415** (0.009)
Presentation quality				0.498** (0.001)	0.375* (0.019)
DEMO					-0.142 (0.389)

Table 1 – Correlations coefficient (p-value)
* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

	Comnunication and Management	Business model	Presentation quality	DEMO	Logbook
Comnunication and Management		0.755 (0.755)	**6.237 (0.044)**	**21.657 (0.001)**	7.706 (0.097)
Business model			1.226 (0.400)	**7.537 (0.036)**	**11.634 (0.004)**
Presentation quality				**22.227 (0.000)**	**5.836 (0.049)**
DEMO					**15.349 (0.007)**

Table 2 - Chi-square test (p-value)

In order to verify the referred associations, we applied the Chi-square test. The results showed that there is no association with Communication and management and Business model and with Communication and management and Logbook. We highlight that the performance in DEMO depends on the level of Communication and management, and of Business model and Presentation quality. The performance in Presentation depends on Communication and management. As to Logbook, it is related, on several levels, to Business model, Presentation quality and DEMO. Presentation quality is influenced significantly by Communication and management. It is interesting to note the significant differences between (Poor, Fair) and (Good, Excellent) from Presentation quality in Peers evaluation like t-test results for independent samples (p=0.002, t=3.316). This suggests that a good or excellent performance in Presentation quality would indicate a high Peers evaluation.

5. Conclusions

In this paper, we provide a case-study assessment tool, TALC for CU of a Bachelor Engineering Degree of ISEP. In this CU, called System's Lab, students work in groups to develop innovative products, recurring to multidisciplinary approaches in the area of business. It was proposed that students developed an innovative idea, construct a business model, a financial plan, an application and presenting their products in a Pitch format. Students' assessment was achieved by grading several parameters, from: communication and time management, presentation quality, business model, logbooks, and exams. The statistical analysis of the results of the implementation of TALC revealed that the Presentation quality was a very important dimension. In this dimension, students have the opportunity to show their competences, gained throughout the course, as well as the possibility to develop a business model.

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