PROMOTING AUDIOVISUAL INSIGHTS IN MATH SUBJECTS

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Abstract

It seems that the digital world is all around us, wherever we turn to. Although not palpable, this world is already an important part of our everyday lives. When we talk specifically about the teaching/learning process we see that, at least in the last decade, the development of alternative and new strategies has been huge. The way students react to some methods and tactics is changing and engaging then into their own learning process is becoming a constant "challenge" to teachers, in all different educational levels. As Math professors in a High Education Institution where Mathematics is a basic and supporting course to other advanced (but non-Mathematical) ones, this so called "challenge" grows exponentially.

In this paper we analyse the impact of introducing and supporting some Math contents through video lectures, in a voice over presentation style, based on animated arrangements, in our own mother language. These videos were developed for a first-year Math course in several Management degrees in the Tourism and Hospitality Area. The specific curricular items were chosen with a primary objective of trying to level up the mathematical competencies that are fundamental to the development of 'mathematical literacy' of our students. Our video lectures are available to students in our institutional Moodle platform, with all its features, along with other resources (as texts and proposed exercises) as well as in a YouTube channel. We will also describe students' background areas of study in pre-university level and analyse if this has any influence in the way they interact with video-lectures in their own learning development and knowledge construction and report student's perception of the eventual benefits of using this digital resource in engaging and promoting their self-responsibility in the leaning process. Finally, we will analyse students' evaluation of the videos recorded by the professors and uploaded to the Moodle platform and YouTube as a learning tool.

Keywords: Video-lectures, Open Resources, Higher Education, Teaching and Learning strategies, Online Education, Technology Innovation.

1 INTRODUCTION

Management Studies applied to Tourism, Hotel and Restaurant areas are the core of the new Organic Unit (OU) from the Polytechnic of Porto (P.PORTO): The School of Hospitality and Tourism (ESHT). This recent OU emerged from the rearrangement of the training offer in our institution, which has transformed the old School of Management and Industrial Studies (ESEIG) into a new educational space (Campus 2) where two new schools were installed: ESHT and the School of Media Arts and Design (ESMAD). With a very recent history, ESHT continuous to offer the several degrees and programs held in ESEIG, some of them since 2006, in the areas of Tourism, Hotel and Restaurant. With an actual training offer of three different Degrees, three Masters, three Post-Secondary Specialization Programs and one Post-graduate program, ESHT "*delivers solutions to the high demand for highly-qualified human resources, capable of undertaking more complex functions, ensuring service quality and differentiation in businesses, meeting the current demands of the Tourism growing sector with "five-stars*" quality" [1].

The study plans of the three Management degrees in ESHT (Catering and Restaurant Management, Hotel Management and Tourist Activities Management) comprise, at the first semester of the first year, a course of Quantitative Methods (QM) - a general and basic curricular unit in Mathematics. This course aims to deepen and consolidate the previous knowledge in the area, as a funding course for any degree in the Management area, starting from Mathematics taught in secondary education, in the Science and Technology Course and in the Course on Socioeconomic Sciences.

The problem to face in these courses is the background differences between the Mathematic level students have when entering these Management degrees. In the next section, we will describe our students background as they presented when asked in a small enquiry at the beginning of the scholar year, since there are not yet any global data available for 2016 National Application Process to higher

education (only available until 2015 in [2]) we depended on the willingness and concern of the students to pass on to us their subject areas as well as the level of mathematics they attended in secondary school. This seems, at the moment, the only and direct way to obtain such information because, despite all information available it is not easy to determine which of the required Exams students use for their entrance grade in Higher Education Institutions (HEI) in Portugal – this grade is a pondered average of their secondary studies (three years) and the Specific Exam they choose from "list", that are, for the degrees in study: 04 Economy, 18 Portuguese and 17 Applied Mathematic to Social Sciences (MACS) or Geography (see Table 1 - to clarify the difference between Entrance Tests with the corresponding codes and exams to be performed [3]). Note that the Specific Exam performed is not directly related to the Secondary School Field of Study, for example, a student may enter with Portuguese from any field of studies, in that sense the student's area of studies does not determine their Specific Exam for entering higher education.

Table 1. *Entrance Tests and Exams to be performed to enter Portuguese HEI*

Entrance Tests		**Exams to Perform**		**Entrance Tests**		**Exams to Perform**	
01	German	501	German (initiation - Biennial)	02	Biology and Geology	702	Biology and Geology
03	Drawing	706	Drawing A	**04**	**Economy**	712	Economy A
05	Spanish	547	Spanish (initiation - Biennial)	06	Philosophy	714	Philosophy
07	Physics and Chemistry	715	Physics and Chemistry A	08	French	517	French (continued - Biennial)
09	**Geography**	719	Geography A	10	Descriptive Geometry	708	Descriptive Geometry A
11	History	623	History A	12	History of Culture and Arts	724	History of Culture and Arts
		723	History B				
13	English	550	English (continued - Biennial)	14	Latin	732	Latin A
15	Portuguese Literature	734	Portuguese Literature	16	Mathematics	635	Mathematics A
						735	Mathematics B
17	**Mathematics Applied to Social Sciences**	635	Mathematics A	**18**	**Portuguese**	639	Portuguese
		735	Mathematics B			239	Only for severe deaf
		835	MACS				
19	Mathematics A	635	Mathematics				

2 STUDENTS CHARACTERIZATION

All the data presented in this section were obtained via an anonymous enquiry (Goggle form), specifically designed for support materials evaluation.

2.1 Students' Field of Studies – Secondary Area

In the next image (Fig. 1), we display the original secondary study fields of students enrolled in QM course. We show separated images for each degree – Catering and Management Degree (CRM), Tourist Activities Management Degree (TAM), Hotel Management Degree (HM) – and, after, a global image of the three aggregated degrees (Fig. 2), to enable an eventual distinction between the different degrees, despite their common central and global development area – Tourism.

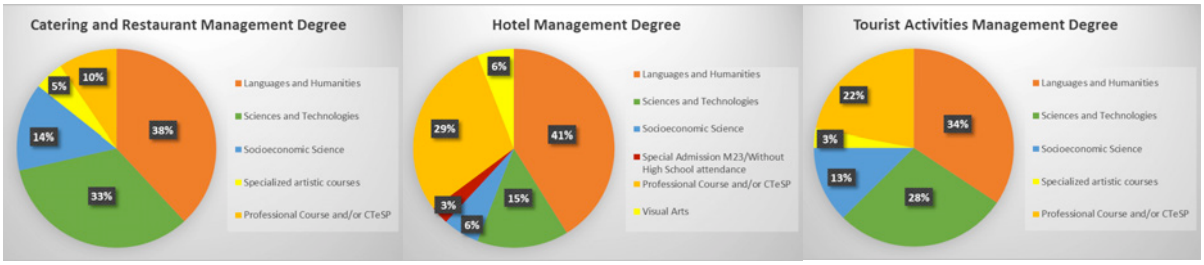

Figure 1 Students' Secondary Study Area

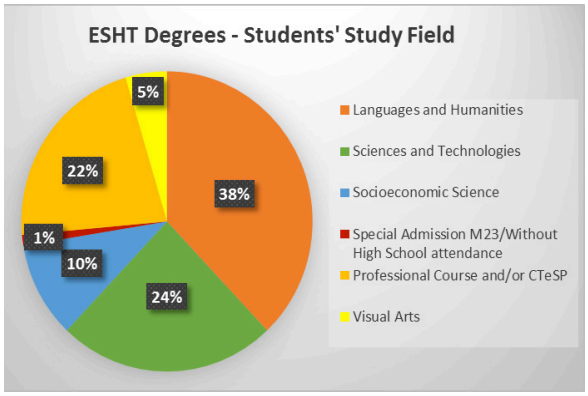

Figure 2 ESHT Degrees - Students' Study Fields

Since CRM and TAM degrees are very recent (the first year just began in 2016/2017) and HM is already functioning since 2010, this last has several repeating students enroled in QM course. These ones are students with a severe handicap in Mathematics, as it can be seen from the secondary areas of study – from the areas of Sciences and Technologies (ST) and Socioeconomic Sciences (SS), we only resgitered 21% (in oposition to 47% of the students from the CRM degree and 41% from TAM degree). Globaly speaking we notice a percentage of only 34% of all students enroled in ST and ST areas.

2.2 Students' background level of Math in pre-university studies

In a similar way, we present in the next images (Fig. 3 and 4), the background level of Math in pre-university studies. Note that these levels are presented in a descending order and that, supposedly, students should enter in the Management degrees with Math A or, at least, Math B frequency. As an image speaks more than words, we leave the following to an open analysis, only referring the direct (and obvious) relation between the study field and the Math frequency level.

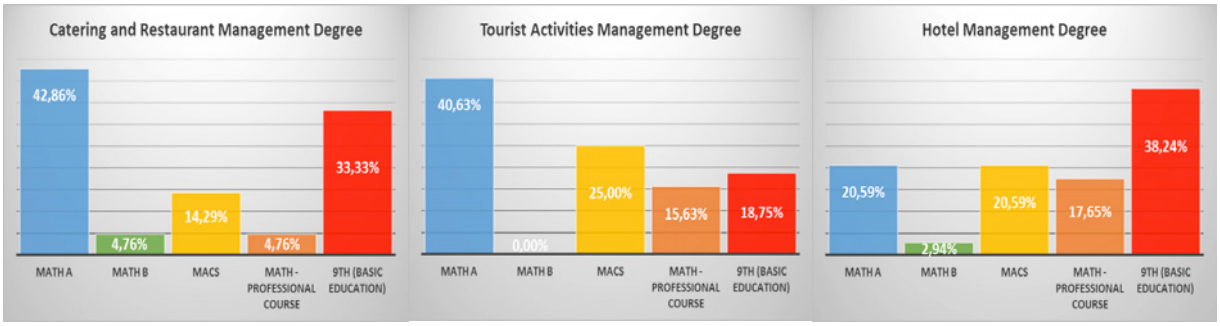

Figure 3 Math Frequency Secondary Courses per ESHT Degree

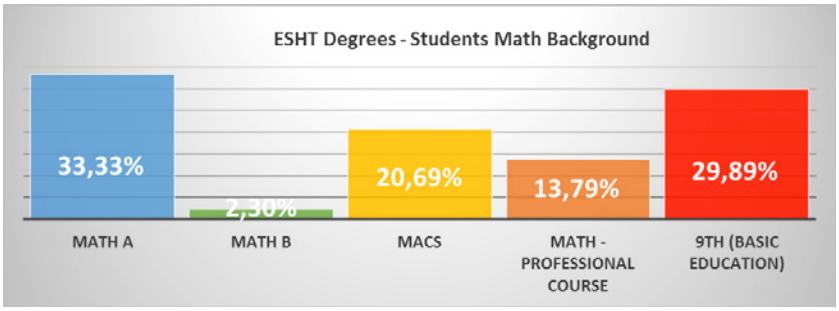

Figure 4 First Year Students - Math Courses in pre-university level

2.3 Math Syllabus in Portuguese Secondary School

To give just a glance of the difficulties that this different Math basic skills confront us, we must consider the contents in the Mathematics curricular unit these students have in the first semester of the first year of these Management degrees (example in Fig. 5, from CRM degree) and into the programs and curricular targets of the three possibilities of Mathematics in Secondary Education Portuguese system. One must notice that almost 30% of the students did not have any curricular unit of Mathematics in their secondary studies (essentially those who came from Languages and Humanities) for, at least, the three last years before entering to the superior education system.

Regarding MACS, being just a two year course (10^{th} and 11^{th}), its contents are, obviously, "shorter" than those of a three year one, like Math A (10^{th}, 11^{th} and 12^{th}), with the aggravating circumstance of MACS having less weekly working hours. Even the specific contents are quite different, beginning in the 10th year with Decision Support Methods - Mathematical Theory of Elections, Statistics and Financial Models, addressing the 11th year, Population Models and Graphs Models, passing through Probability Models and ending with Introduction to Statistical Inference ([4]).

In what concerns the Mathematics B, although this is present in the three school years, the weekly schedule (3h) is almost half of Mathematics A (5h), which implies that the subjects are often covered without the necessary "deepness". The issues in question are various, starting in the 10^{th} grade with Geometry in the Plane and Space, Functions and Graphs - General - Polynomial Functions and Statistics, passing through Periodical Movements and Non-linear Movements, where the Rational Functions are addressed (11^{th}). The subjects end addressing Probability Models, Discrete Models (sequences), Non-linear Continuous Models (exponential and logarithmic), finishing with Optimization Problems ([5],[6],[7]).


Course Form

Academic Year 2016/2017

Course	Quantitative Methods
Degree	Licenciatura em Gestão de Restauração e Catering
Assessment plan	Daytime Classes
Technical and Scientific Unit	Departamento de Informática e Matemática

Total Workload / Weekly	172.0	Academic year / Term	1st Academic year / Winter Semester
Horas Outra	108.0	Attendance	Mandatory
Theoretical/Practical Work (hours)	64.0	Number of Credits (ECTS)	4.0
		Language	Portuguese
		Prerequisites	
		Course Responsible Teacher	Doutora Filomena Soares
		Course Teacher	Doutora Filomena Soares

Syllabus

Learning Outputs

General outcomes/skills
1. To clearly structure a logical reasoning, consciously identifying all its phases, perceiving Mathematics as a tool for other Curricular Units;
2. Recognize and interpret new subjects of Infinitesimal and Integral Calculus, Statistics and Probabilities, required for a proper Mathematical training in a Management Degree, in particular in the Catering and F&B (Restaurant) areas.
Specific outcomes/skills
3. Sketch and interpret graphs of functions with economical interest, identifying some Mathematical Models typical characteristics (exponential and logarithmic, polynomial), critically analysing the proposed solutions;
4. Develop skills in students to select the best methods and techniques for a particular purpose and for a given set of data using a statistical software (IBM SPSS);
5. Interpret, organize and present the statistical results

Syllabus

1. General and basic concepts of one variable Real functions
1.1. Pre-calculus review
1.2. Particular Functions Review: polynomial, exponential and logarithmic
1.3. Some Economical Functions
2. Differential Calculus in IR
2.1 Definition and geometric interpretation of the derivative # notion of differential
2.2 Differentiation rules
2.3 Applications in Economics: Marginal Functions and Elasticity
3. Integral Calculus in IR
3.1 Antiderivative notion - Indefinite Integral and its properties
3.2. Direct Integration: The Rules of Integration
3.3. Integration Methods
3.4 Definite Integral and its properties
3.5 Fundamental Theorem of Integral Calculus
3.5. Application of Integrals: Areas computation, Mean Value of a function; consumer and producer surplus
4. Statistics
4.1. Data Organization
4.2 Descriptive measures;
4.3 Regression and correlation
5. Probability and combinatorics
5.1 Random Experience, set of results; events
5.2 Classical Laplace Probability Definition
5.3 Combinatorial Analysis

Figure 5 Mathematics Course Syllabus (excerpt)

Regarding the Mathematics, A contents, the subjects are covered in more depth and there is a greater concern for scientific rigor. Thus, in a similar minimalistic way, the program comes down to the following main points along the three years: Geometry in the Plane and in Space(10^{th} and 11^{th}); Analytic Geometry; Function and Graphics: generalities about functions; Descriptive and Inductive Statistics; Introduction to Differential Calculus - Rational and Radical functions, Exponential and Logarithmic Functions (11^{th} and 12^{th}); Rate of change and Derivative Function (11^{th} and 12^{th}); Real Sequences (11^{th}); Probability and Combinatorics (12^{th}); Trigonometry and Complex Numbers (12^{th})([8]).

With such different competences, being developed in secondary school, dealing with these differentiated backgrounded “minds” is not an easy task to teach Mathematics to students with so different backgrounds.

3 VIDEO DEVELOPMENT AND USE

Several HEI, particularly those in which Mathematics is a necessary pre-requisite for their courses, must deal and try to tackle what seems an “universal” problem - the difference between the “levels of mathematics knowledge and skills” of their incoming students. Watching the remarkable success of many Open Educational Resources (OER) we felt that students (as well instructors) could only benefit from the development and use of different resources and, in that sense, video-lectures seemed an appealing one.

Our key objective, when developing several video-lectures in our own mother language, was to take advantage of a handy tool that could contribute to complement different Mathematics backgrounds of the students, trying to “fill” in the gap between high school and higher education and offer a friendly tool to support the management of each ones’ learning commitment.

Video Materials were chosen also by a combination of other factors as former teacher experience with video editing for MOOC ([9],[10],[11]), the daily use of Learning Management Systems (LMS) like Moodle platform as an open tool for students to access all available resources and the former development of other several projects (M100S [12],[13],[14], MatActiva Project [15], [16]). With the use of video-lectures for some curricular items, essentially in Calculus revision subjects, we tried to improve and experience other teaching and learning models, promoting a “doing” methodology, with the use of new technologies in the learning-teaching process and as flipped-classroom basic tool.

3.1 Video Editing

The video-lecture type used was the “Voice Over Presentation” style [17], whose main component is usually a PowerPoint presentation, with several animations (see example in Fig. 6), complemented with a voice over explaining the slides. This option was taken after analysing that both lecture capture and screen casting recordings served as useful supplementary materials for student learning [18]. However, most students preferred the quality and usefulness of the screen casting recordings to lecture capture recordings. Recent research emphasizes that video lectures can provide important benefits to students [9] and we have personally experienced this fact.

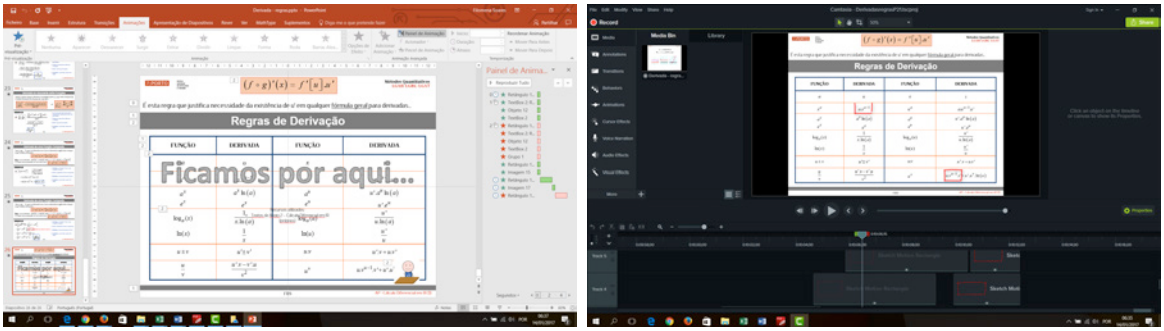

Figure 6 Video Editing - example

Videos were edited and created with Camtasia Studio software for a dynamical editing performance (Fig. 7) and their length was established to be between 5 and 10 minutes, with the constant concern, when necessary, to segment the same subject into two or more video-lectures, keeping always in mind that it is preferably to have less than 6-7 minutes.

The use of some background music was previously tested but after some valuations of previous visualizations (video piloting type), this option was abandoned since it was felt, by the volunteer students who tested them, as a distracting and not appealing or engaging factor.

3.2 Video Broadcasting

In the following images, we can see some print screens of Moodle platform were the videos were made available to students, in a pop up display. Students could download and use them whenever they pleased. This option turned out as “not the best one”, in terms of the learning analytics procedure, since it is not possible to tackle video use in students’ personal computers. But, despite this factor, open resources are supposed to have an open utilization and this was a personal compromise towards developing different and differentiated teaching and learning procedures. The “big brother” alleged failure was overcome with a constant “in class” reference to video-lectures, giving teachers the perception of their potential utilization, tracking the download numbers in Moodle platform and with a small questionnaire at the end of the video supported subjects.

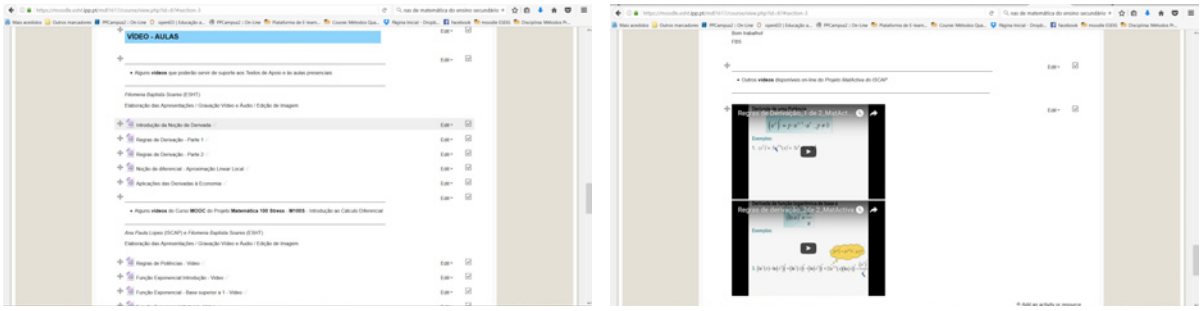

Figure 7 QM Moodle page print screen

Notice that, in this Moodle QM page, students have at their disposal, supporting Texts and related Proposed Exercises (with solutions) as well as links to other available and open resources. In the next section, we will try to compare the relative importance students give to all the supporting materials they had available and/or used.

Several animated gifs as well as quite a lot of Camtasia software animated callouts, were used in our videos, as we try to show in Fig. 8 (despite the difficulty in transmitting movement through a static image).

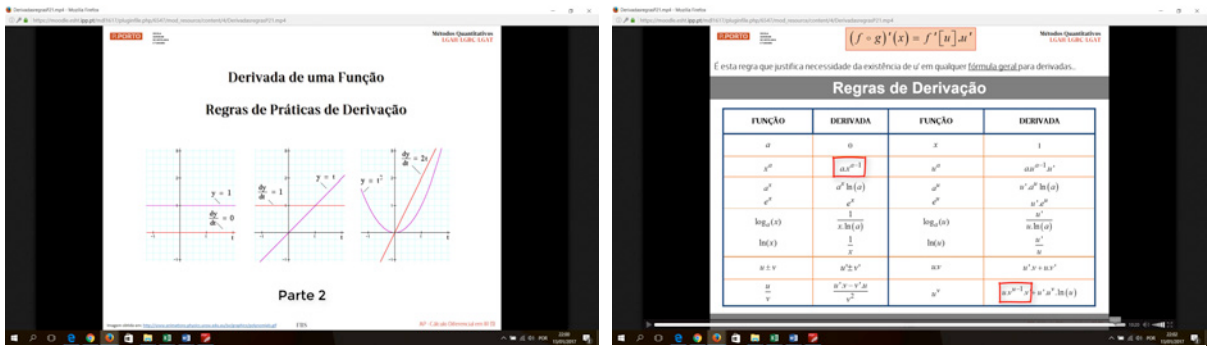

Figure 8 Video-lecture print screens

Videos were used as a “before” and “after” classroom tool, in the sense that students were asked to watch the video-lecture(s) before coming into class and, there, the subject was discussed and explained as well as several application problems were debated and solved. We felt that some students with more “weaknesses” were very engaged but others were not sufficiently autonomous to embrace and be involved with video-lectures, they felt a little bit lost at the beginning and it took a while before they felt it was useful for them as a self-guide in the learning process.

3.3 Video Utilization

From Moodle platform reports (without any extra Learning Analytics block plug in) we could collect the following data regarding video-lectures “use”. Notice that the top sections were the last ones (time flows upwards).

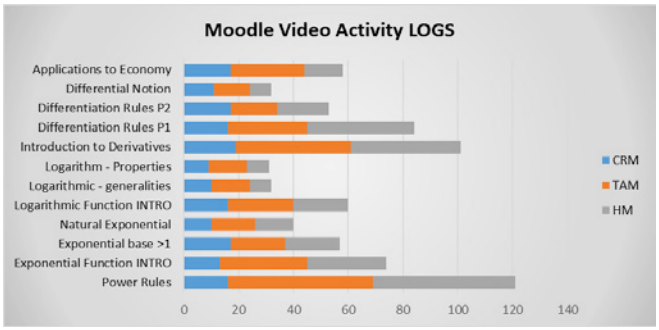

Figure 9 Video Activity Logs per degree

There are some important features in this image interesting to analyze: when starting a subject, students tend to "work" a little bit "more" - notice the differences when starting with Power Rules (revision item), we came across Logarithmic Functions and, afterwards we go through Differential Calculus, starting with the derivative notion. At first, HM students were the most participating, when comparing the three degrees in stake, but, when time flows, they become less participative. Although this seems a common "movement", the differences are more reduced in the CRM degree students.

Just having in mind the image above, we must conclude that, despite the degree students are enrolled in, their behavior is not significantly distinct.

4 STUDENTS' RESOURCES EVALUATION

The survey registered 87 valid answers with a different proportional percentage distribution per degree (see table 2). This is due to the fact that several students have quitted QM course, leaving this to final assessment (or, unfortunately, for the next year…) and this is more common in degrees were we have more students and repeating ones, as in the case of HM and TAM.

Table 2. *Enrollment versus Answers*

	Students enrolled	Obtained answers	Percentage
CRM	29	21	72%
TAM	83	32	39%
HM	103	34	33%

Four students, of the 87 that took the survey, stated that they never used the resources (texts/exercises/videos) available on the Quantitative Methods page in ESHT's Moodle, and, did not evaluated the available resources but contributed to a final question of video-lectures relevance perception. These 4 students were: one freshman from TAM and 3 repeating students from HM.

The students that used Moodle platform resources were asked to "*Rate the importance of having each of the following resources as a valid contribute to your learning process*" in a 1 to 6 points (Likert Scale), where 1 meant "not-important" and 6 "very important". We opted for a number greater than 4 in order to promote reliability and scale validity [19] and an even one to avoid the tendency to "respond in the middle" when we do not want to "think too much about it." With an even number, even the median responses show some tendency, even if little striking.

Table 3. *Survey results – part 1*

Resources	Not-important 1	2	3	4	5	Very-important 6
Supporting Texts	2%	4%	2%	22%	18%	52%
Proposed Exercises	0%	0%	1%	8%	22%	69%
Video-Lectures – Own teacher's edition	5%	5%	8%	17%	24%	41%
Links to other open resources online (texts, videos, etc.)	4%	5%	17%	28%	26%	20%

It is important to notice that video-lectures reveal to be only in the third "overall" position: positive feedback rounds 82% with a strong positive opinion from more than 41%. It is interesting to refer that students are more reluctant in using new resources than we were expecting, and we felt that, essentially freshmen, were very insecure and dependent on the traditional lesson, within the classroom giving relying essentially on Supporting Texts and Proposed Exercises.

The final question - "*Regardless of your Moodle's use do you consider video-lectures an useful resource to be developed for all syllabus items?*"- was answered by all 87 students, does not show any relevant improvement (Fig. 10) passing from a 82% of positive answers to 84% with a drop of 5% in the highest grade (6),

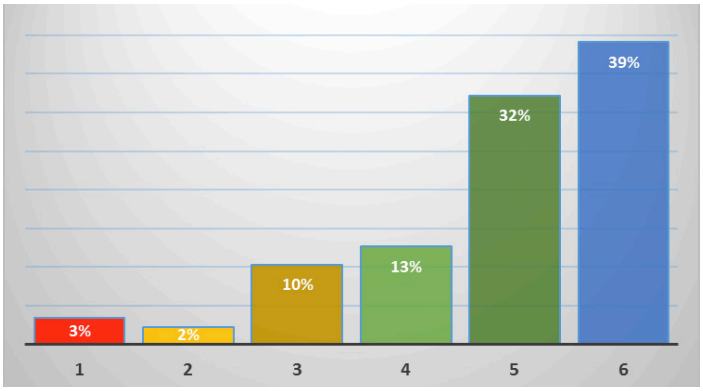

Figure 10 Relevance of Video-lectures resources in the Teaching-Learning process

5 FINAL COMMENTS

We started this academic year with high expectations regarding the promotion and use of new resources in the QM course. This small venture was, in our and students' opinion, a successful one, with a positive assessment feedback, to be continued and developed in the next years.

Despite the positive features presented, there are, obviously, several difficulties to keep in mind: Financial restrictions – These prevent from having an ideal number of students per class and complicates the implementation of inverted teaching more times, and it is not possible to stimulate students' autonomy through individualized monitoring. This is a real constraint that affects learning procedures and outcomes when having to work with forty (or even more) students at once, inside a classroom and, simultaneously, try to deal with different learning skills; Frequent high absenteeism rates – This is a fact, essentially, relative to repeaters, some "leave" Math courses to last and others struggle to make Math schedules compatible with second and third years courses in order to attend classes; Low motivation to learn – Since Mathematics is a subject so unloved in High School, it is not easy to reverse "feelings", so common, due to effective study fields from which these students come from.

As we have already mentioned, the "weak" training mathematics that many students have received is a fact, but another fact is that we accept them and therefore they are our reality, the reality of our school from the P.Porto. In this sense, we hope that next year it will be possible to implement a new

project in this Mathematic course, to promote success through students' active participation in their learning process. This will only be viable if students with differentiated backgrounds can attend distinguished classes with a different number of contact hours, since we feel that we have to deal with this problem in the first year course. Like plan this has its fails, not exempt of objections and obstacles either in its implementation or in its pursuit, however, the development of a conscientious work is not possible when we notice students' difficulties without, at least, trying to do something.

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