STATISTICAL TOPICS IN UPM ENGINEERING DEGREES

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Abstract: This present moment of transition to the European Higher Education Area (EHEA) [1] makes it necessary to re-evaluate the learning outcomes of all the subjects taught in Spanish universities in order to adapt them to the graduates' professional future, as specified by the new catalogue of degree courses. The Polytechnic University of Madrid (UPM) is among the Spanish universities offering the largest number of courses in engineering and technical subjects.

With the change to the EHEA, the UPM will offer a 4-year degree course, followed by a Masters degree involving an additional two years' study. Both degrees may be officially recognised by the Spanish national government.

For the 2009-2010 academic year, the UPM is offering 10 new degree courses which adapt to the EHEA (www.upm.es), all of them with a duration of 4 academic years. The remaining degree courses will be adapted by the 2010-2011 academic year.

The subject of Statistics is not only useful for summarising information and making decisions based on small amounts of data, it is also a convenient tool for shaping scientific thought [2], and affords a suitable methodology for resolving real problems [3].

An analysis of the contents of this subject in the UPM's current syllabuses is a useful contribution to the restructuring and correcting of any possible deficiencies in the class programmes in order to adapt them to the new demands for the teaching of engineering and technical subjects.

The subject of Statistics is a common feature of all the degree courses offered by the UPM. It is usually an obligatory subject in the first 3-year cycle of 5-year engineering and technical courses, and a core subject in 3-year courses.

This paper reviews the syllabuses for the different degree courses which appear on each university website in order to analyse the common learning outcomes in the subject of Statistics in the teaching programmes taught in the UPM.

Key words: content, statistics, syllabuses, engineering

Introduction

Until the 2010-2011 academic year, the courses available in the Madrid Polytechnic University (UPM) under the Spanish system were first, for the title of "engineer", "architect", or "graduate" (courses taught only in Higher Schools of Engineering, Higher Technical Schools, or University Faculties) with a duration of 5 years (6, in the case of Civil Engineering and Forestry), consisting of a total of 18 degree courses; and second, for the qualification known as "technical engineer" (taught in University Schools) lasting 3 academic years (or 4 years in the case of "technical architect"), with a total of 24 degree courses.

The teaching of Statistics is one of the common features of the degree courses taught in the UPM. The depth to which the subject is studied depends on the knowledge required for the remaining subjects in the various degree courses.

We proposed comparing the different Statistics contents in each of the degree courses so that the learning outcomes and the abilities and skills that need to be acquired by students at the UPM can be re-evaluated with a view to adapting the degree courses to the EHEA.

Methodology

The comparative study was based on the information obtained from the UPM website **(www.upm.es)**, and the data were complied in the different universities with the help of the teaching and management staff. It should be noted that this information is not always widely available on the Internet, and in some cases can only be accessed by students who are registered for the subject.

Tables 1 and 2 show the different names with which the various Statistics subjects are designated in each university in each syllabus. The tables also show the type of subject and the number of credits (One Credit = 10 class hours) assigned to the subject of statistics (in subjects where Statistics and Mathematics are combined, the number of credits was calculated from the percentage of class hours dedicated to Statistics out of the total of hours for the subject as a whole).

Table 1. Statistics in Higher Technical Degrees (5-6 years). Compiled by authors.

DEGREE COURSE	SUBJECT NAME	YEAR	TYPE	CREDITS
Aeronautical E.	Applied statistics	3	Obligatory	6
Agricultural E.	Fundaments of statistics	2	Core	6
Architecture	Statistical Methods I	2, 3, 4, 5	Optional	2,5
	Statistical Methods II	2, 3, 4, 5	Optional	2,5
Civil E.	Applied statistics	3	Obligatory	12
Geodesics and cartography	Fit of observations and optimisation	1	Obligatory	4,5
Geology	Applied statistics	3	Obligatory	6
Industrial E.	Statistics	2	Obligatory	9
Computer science	Statistical inference	2	Obligatory	4,5
	Probability and statistics	2	Core	6
Forestry E.	Applied statistics	3	Obligatory	12
Mining E.	Statistical methods	4	Obligatory	6
Naval E.	Introduction to statistics	3	Core	4,5
Environmental sciences	Mathematics and applied statistics	1	Core	7,5
Telecommunications E.	Introduction to random signals	2	Obligatory	6
Physical education and Sports sciences	Data analysis in P.E. and S.S.	2	Obligatory	4
	Introduction to research in P.E. and S.S.	3	Obligatory	4

Table 2. Statistics in Technical Degrees (3 years). Compiles by authors.

DEGREE COURSE	SUBJECT NAME	YEAR	TYPE	CREDITS
Aeronautical E.	Experimental techniques	1	Obligatory	4.5
Agricultural E.	Applied statistics	1	Core	4.5
Architecture	Extension of mathematics	2 and 3	Optional	6
	Experimental design and regression	2 and 3	Free choice	6
Forestry E.	Statistics	1	Core	2
Industrial E.	Statistical methods in engineering	2	Core	6
Computer science	Statistics	2	Core	9
Mining E.	Extension of mathematics	2	Core	6
Civil E.	Linear algebra (statistics)	1	Core	6
Telecommunications E.	Statistics and stochastic processes	2	Obligatory	6
	Statistics	2	Obligatory	4.5
Topography E.	Mathematics I	1	Core	1.5
	Mathematics II	2	Core	3.5
	Fit of observations	2	Obligatory	7.5

Results

The tables above indicate that the Higher Technical School degrees with the greatest dedication to the subject are as follows, in descending order: Civil Engineering (6 years), Physical education and Sports sciences, Forestry (6 years), Industrial engineering and Agronomy, where the subject is actually designated and taught as the subject of Statistics.

In the University Schools (3 years) the subjects with the greatest dedication are, in order of importance: Forestry, Computer science and Topography. This last includes statistics topics within the subjects of Mathematics I and II.

Environmental sciences and Geodesics and Cartography are what are known as 2nd-cycle courses, consisting of 2-year courses for students with a prior university degree of either 3, 5 or 6 years. In both these cases their statistics content is taught in a single subject in the first year of the 2-year course. In Environmental sciences it is a core subject and in Cartography it is an obligatory subject, with a different number of credits in each case.

In most degree courses there is a single Statistics subject. In the Topography course, Statistics is taught as part of three different subjects, of which two are Mathematics I and II. In Computer Science, Physical Education and Sports sciences, and Telecommunications engineering the content is taught in two subjects, each with a different number of credits.

In Architecture and Technical architecture two subjects are taught in each degree course, although all four of these are optional or free choice and can be chosen in different years.

The subject is offered as obligatory in 56% of the remaining degree courses, and as core in 44% (Figure 2).

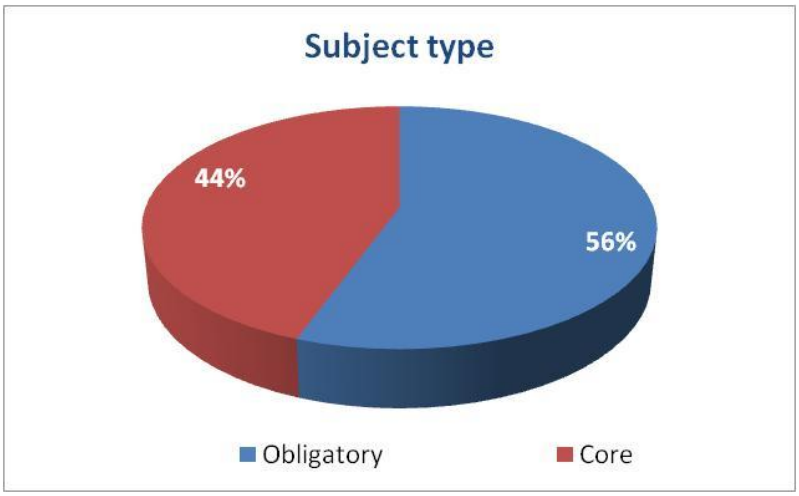

Figure 1. Percentage of degree courses according to subject type.

In the case of the years in which the subject is taught, the most frequent is the second year of the course (8 courses), followed by the first year (6 courses), and the third year (5 courses). Figure 2 shows the percentages for the years in which statistics is taught in the different degree courses.

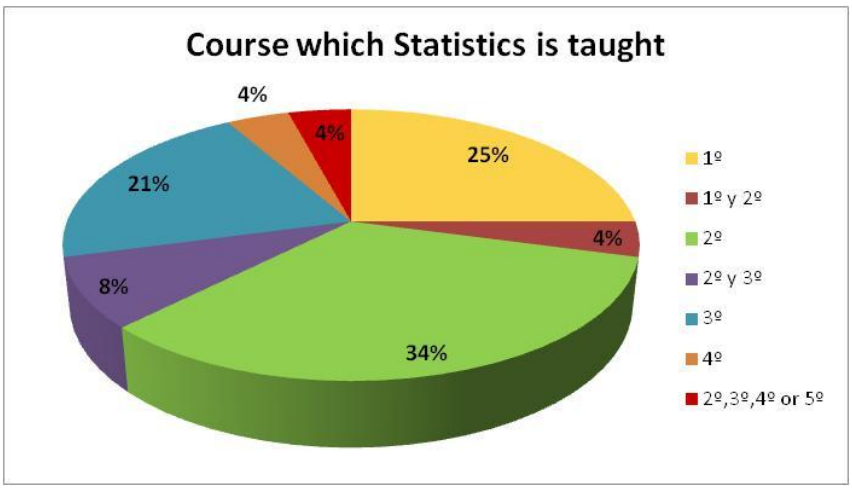

Figure 2. Percentage of degree courses according to year.

Regarding the blocks of topics in the subject, Table 3 shows the number of topics which are taught in the subjects in the degree courses in the UPM according to the different blocks of topics.

Table 3. Statistics topics taught in UPM degree courses

TOPICS	Higher Technical Schools	University Schools	TOTAL TOPICS
Descriptive statistics	8	10	18
Probability	13	9	22
Distribution functions	8	6	14
Sampling distribution	8	1	9
One-dimensional random variable	11	6	17
Multi-dimensional random variable	9	3	12
Regression	12	5	17
Estimation	8	2	10
Hypothesis Test	8	5	13
Nonparametric test	3	0	3
Inference	4	6	10
Stochastic processes	4	1	5
Practical exercises with Statgraphics	5	2	7
Multivariate analysis	1	0	1
TOTAL TOPICS	102	56	158

Figure 3 shows the number of topics taught in the different types of degree course.

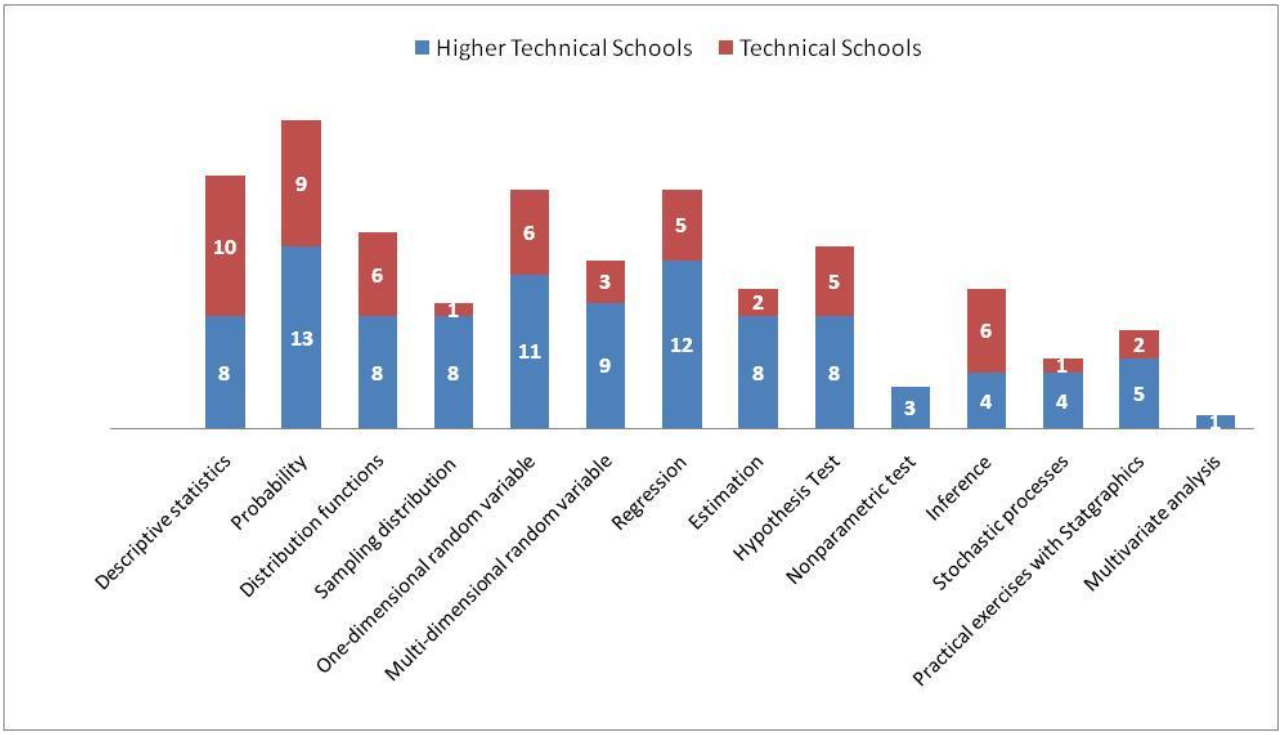

Figure 3. Topics according to type of degree course.

The topics taught in degree courses in the Higher Technical Schools are approximately half those in the syllabuses for the rest of the degree courses. They comprise 35.44% of the total.

Probability calculation is the most commonly taught topic in the UPM, followed by descriptive statistics, regression and one-dimensional random variable models.

It is worth noting the scarce presence of practical computer classes with the Statgraphics program in 7 of the 27 degree courses. Given the imminence of the forthcoming adaptation of the university to the EHEA, this type of learning techniques should be incorporated into the syllabuses for this subject.

Regarding the credits assigned to the subject of statistics, no significant statistical differences can be seen between the degree courses in the Higher Technical Schools (3 years) and the rest.

The minimum number of credits is 2 and the maximum 12.5. The mode and the median are 6 credits and the average is 7.33. The standard deviation is 2.94 credits.

The chart in Table 4 (from a steam and leaf diagram, [4]) shows the ordered information for the total of credits assigned to the teaching of statistics within the degree courses as a whole. The accumulated frequency shown in the first column is the sum of the degree courses with the same or lower number of credits as the contents in the row.

Table 4. Credits taught in UPM degree courses

Accumulated frequency	Credit interval	Credits assigned
1	[2.3)	2.0
1	[3.4)	
5	[4.5)	4.5; 4.5; 4.5; 4.5
6	[5.6)	5.0
14	[6.7)	6.0; 6.0; 6.0; 6.0; 6.0; 6.0; 6.0; 6.0
15	[7.8)	7.5
16	[8.9)	8.0
18	[9.10)	9.0; 9.0
20	[10.11)	10.5; 10.5
20	[11.12)	
24	[12.13)	12.0; 12.0; 12.0; 12.5

There is a high variability in the credits and there are no outlier data.

CONCLUSIONS

To adapt the UPM's degree courses to the EHEA it is necessary to review the contents of the subject of statistics as applied to the teaching of engineering and technical subjects. The teaching of statistics is a common feature of the degrees offered by the UPM, and is compulsory for most of the degree courses. The classroom time is two and a half hours per week on average. The use of statistical software for the teaching of this subject is not widespread.

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