

A GENERAL STUDY OF THE MATHEMATICAL IMPACT IN TECHNICAL CURRICULA

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Abstract $\frac{3}{4}$ The most of the authors about the topic of University Curricula Design, point out the importance of defining the professional fields, where the future graduates are going to develop their jobs, in a coherent and up-to-date manner, with the aim of using this information in order to select the contents of the different subjects of the syllabus, which is being tried to be constructed. In the case of “instrumental” disciplines such as Mathematics, Physics or Design, a special treatment is required in order to accomplish this problem, since their relation with the real-life socio-economic activities is less evident. Here is the topic we deal with in this paper. In order to solve it we propose a procedure which allows us to define the skills and knowledge to be acquired by engineering students, in relation with the “instrumental” subjects, with the goal of selecting the most suitable contents of their syllabus, and of scheduleing them in an interdisciplinary way. The final purpose is to construct a educational syllabus in contact wite the society and to encourage the students.

Index Terms $\frac{3}{4}$ Curricula Design, definition of professional fields, selection of contents, schedule.

INTRODUCTION

As said in the abstract the main objective of this work is to present a method in order to select and to schedule the contents of the syllabus of the “instrumental” disciplines, in connection with the socio-economic environment, and in a interdisciplinary context.

This propose has as a precedent in our Eduational Project, hereafter (EP), entitled in Spanish “Estudio de la Incidencia de las Matemáticas en el Curriculum de la Carrera de Arquitecto Técnico”, that present-day we are carrying out in The School of Technical Architecture of the Polytechnical University of Valencia (Spain), with the financial support of the Education Sciences Institute of the Polytechnical University of Valencia.

The general objectives of our project are:

- Performing a study of the relation between whatever “instrumental” subject, A, with the remaining subjects of the curricula of the whole degree B.
- Evaluating whether the students begin the study of the subjects of the curricula of B, with the level of knowledge of A, that are required in each one of them.

- Performing a collection of real-life profesional problems of the curricula of B, where one can “touch” the presence of the knowledge of the subject A.
- Proposing a coherent review of the contents of the subject A, closer to the real necessities of the degree B, and to the profesional enviornement..
- Improving the coordination between the subject A and the remaining ones of the curricula of the degree B.

To achieve these objetives we propose the following protocol of activities:

- Setting up an interdisciplinary team of teachers.
- Searching for financial support.
- Editing a poll to collect information.
- Taking the poll on.
- Collecting and treatment of the data.
- Editing tables and graphics to present the results.
- First conclusions.
- Feedback.
- Last conclusions.
- Final report.
- Developing a suitable software.

Throughout this paper we are going to develop with detail the general lines that we have outlined in this introduction. We will illustrate the main ideas with examples of the EP. We start by explaining the poll.

THE POLL

First of all, as it is logical, we must begin with the setting up of an interdisciplinary team of teachers, hereafter (TT) with the following structure::

- Teachers of the subject A. One of them must be the manager of the project.
- At least a teacher of each one of the remaining subjects of the degree B, in which the subject A has some influence.
- The teachers are grouped in several areas of knowledge, with similar topics, with a leader.

The first activity to be accomplished by TT is the edition of a consulting poll. This poll will be sent to all the professors of the degree B, with the aim of collecting

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information about the influence of the subject A in the curricula of the degree B.

In order to decide whether either a concept or a skill of the subject A (item) has or has not influence to follow another subject, C, of the syllabus of the degree B, we must ask the teachers of the subject C for the **importance** of said item in order to understand the contents of the subject C. See Figure I.

We must also ask them for the **frequency** or the numbers of times, more or less, that the item is used in the contents of the subject C.

Both variables: importance and frequency will serve us, as a criteria of selection of the items, and therefore, of the contents of the subject A, according to our purpose.

In order to coordinate the subject A with the other ones of the syllabus of the degree B, it is very interesting to ask them for the first time when the item is used in the subject C. In particular we ask them for the month of the year, when the item is used for the first time. In the poll this variable is called **Sequence**

It is also interesting to have information about the level of previous knowledge of the item of the subject A, when this item is required for the first time in the subject C. In the poll this variable is called **Level of previous knowledge**.

Summarizing the poll has four variables: Frequency, importance, level of previous knowledge and sequence. The three first can be evaluated from 1 to 5, (although in Figure I it is from 1 to 4, now we advise 1 – 5 because the existence of an average value is better), and the sequence by pointing out the suitable month.

In the last page of the poll two interesting sections appear. The first one, titled **Other concepts**, let the teacher of the subject C to add and to evaluate new items of the subject A, that he or she needs in order to explain C. The second one, titled **Suggestions**, in order to ask for new ideas to improve the project.

Other important question is the choice of the list of items of the subject A to be evaluated. In our opinion one first propose, as kind of a draft, must be done by the teachers of the subject A of the TT. To carry out this activity, they can begin by the present-day items of the subject A, selecting the more outstanding, because they are important in order to understand the whole, or some part, of the subject A, because they are frequently used in the development of its syllabus, or because it is necessary to take a lot of time to explain them well. Of course the list of items must also cover the legal requirements.

To denominate the items we have to avoid specific technical words, for them to be understood easily by the teachers of other subjects different to A.

We must order the items in the poll, collecting them into modules of similar contents, with the purpose of making the reply required easy.

The number of items of the poll, in our opinion, must be between 100 and 125, otherwise it will be inefficient.

Once done, this first draft of the poll by the teachers of the subject A, it will be presented to the other professors of the TT to discuss the following problems:

- The included items belong to the present-day syllabus of the subject A. Now we ask for the existence of other items of the discipline A, that they are not in the syllabus of the subject A, but that they can be needed by other subjects. As it is logical, detecting these items is very important for the project.
- Is it clear for all the members of the team the definition of the variables frequency, importance, level of previous knowledge and sequence and how to reply to them?
- Is there new ideas of suggestions in order to improve the poll edition?

As an illustrative example we present in Table I the first ten items, of 104, belonging to the EP.

TABLE I
THE 10 FIRST ITEMS OF THE EP

1.	Enteros y fraccionarios
2.	Teoría de proporcionalidad
3.	Números reales
4.	Error de un número real
5.	Números complejos
6.	Sucesiones de números reales
7.	Funciones polinómicas
8.	Funciones trigonométricas
9.	Funciones hiperbólicas

Finally we must develop some tests in order to make sure of the coherency in the reply of the poll. Assume you need an item of the subject A, a , to solve some question of the subject C. Suppose that using the item a involves using item b too. Then item b must be more frequent than item a . If it were not in this way, we would have to find out why, before considering the reply as good.

Done all this, the poll will be sent to all the teachers of all the subjects of the syllabus of the degree B.

TAKING THE POLL ON

With this activity we are going to collect the most of the information, which the final results of the project are going to be based on, therefore it is necessary to accomplish it with a lot of efficiency. All the TT must motivate the participation, each one of them in his or her own subject. Moreover we propose the following complementary actions:

- Search for the institutional support from the School to move the teaching staff to participate.
- Schedule meetings subject after subject with the aims of explaining the project to all the teachers of the School, giving assistance to answer the questions of the poll

FIGURE I
ONE PAGE OF THE POLL OF THE EP

VARIABLES																	
FREQUENCYCY				IMPORTANCE				LEVEL OF PREVIOUS KNOWLEDGE				SEQUENCE					
No present				Little important				Very deficient				september					
Little frequent				Important				Deficient				october					
frequent				Very important				Good				november					
In all the themes				Essencial				Very good				dicember					
												january					
												february					
												march					
												april					
												may					
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correctly, and finally searching for new members of the TT until achieving all the subjects of the degree B have a teacher in the TT.

Carrying out all these ideas in our school, we achieved a participation of 82 professors, of a total of 127,. Moreover we got information about all the subjects of the degree, and our TT has, at least, a member of each one of the subjects of the degree. In Table II we illustrate the results of participation in the first academic year.

TABLA II
FIRST ACADEMIC YEAR
EE: SENT POLLS
EC: ANSWERED POLLS

Asignaturas - Primero	E.C	E.E.
Materiales de Construcción I.	5	5
Construcción I	3	7
Geometría Descriptiva	2	6
Fundamentos Físicos	7	9
Topografía y Replanteos	4	5
Dibujo I	6	9
Economía aplicada	4	5
Mecánica de las Estructuras	7	9
Totales	38	55

THE TREATMENT OF THE DATA

In this section we introduce, as examples, the data and its treatment, that we obtained in the EP, since the followed procedure can be easily generalized to the study of whatever “instrumental” subject A, belonging to whatever degree B.

Table III displays, in a summarized way, how to connect the items with the subjects where they are present, with respect to the variables frequency and importance.

TABLA III
RELATION BETWEEN ITEMS AND SUBJECTS

Items	Mat. I		Econ.		FFAT		Cons I		Dib. I	
	Fre	Imp	Fre	Imp	Fre	Imp	Fre	Imp	Fre	Imp
1	3	4	3	3	4	4	2	1	4	4
2	3	4	3	3	3	3	0	0	4	4
3	4	4	3	3	4	4	0	0	2	1

Next we are going to define the following statistics parameters:

P_A: Percentage of subjects where it is answered that the item is used. $P_A \in [0,10]$

Y_F: Percentage of polls where it is answered that the item is used with a frequency values of 3 or 4. This percentage is computed taking into account only the polls where the item is required. $Y_F \in [0,10]$

Y_I: Percentage of polls where it is answered that the item has an importance values of 2, 3 or 4. This percentage is

computed taking into account only the polls where the item is required. $Y_I \in [0,10]$

Y_P: Percentage of polls where it is answered that the level of previous knowledge is good or very good. This percentage is computed taking into account only the polls where the item is required. $Y_P \in [0,10]$

Max: Maximum score obtained by the variable importance, taking into account all the polls where the item is required. $Max \in [1,4]$

P_E: Percentage of polls where it is answered that the item is used. $P_E \in [0,10]$

X_F: Average of the scores obtained by the variable frequency, taking into account the polls where the item is required. $X_F \in [0,10]$

X_P: Average of the scores obtained by the variable level of previous knowledge, taking into account the polls where the item is required. $X_P \in [0,10]$.

And the vectors

Vector I: (P_A, Y_F, Y_I, Y_P)

Vector II: (P_E, X_F, X_I, X_P)

Table IV shows, in a summarized way, the data of Vector I, with respect to the two first items introduced in Table I.

TABLA IV
VECTOR I

Item	P _A	Y _F	Y _I	Max
1	9,00	8,50	8,80	4,00
2	8,60	7,90	9,60	4,00

In a similar way, Table V shows the datas of Vector II

TABLA V
VECTOR II

Item	P _E	X _F	X _I
1	9,3	7,75	7,25
2	9,3	7,25	7,50

CONCLUSION

We are not going to develop here the conclusions in detail. It will be the topic for another paper, however we are going to describe the process in the following steps:

- From all information of the preceeding section, a first classification of the items is made, according to the variables of frequency, importance and level of previous knowledge.
- We are also going to do a first study of the coordination of each one of the items, with the remaining subjects of the degree.
- This done, the whole TT will perform a collection of real-life professional problems of the curricula of the degree, where one can “touch” the presence of the knowledge of the subject A in the whole curricula.

- This collection of problems will provide new information, and it will serve as feedback of the whole project.
- The final conclusions and reports.

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