AN INTRODUCTORY COURSE TO STATISTICAL CONCEPTS, THEORY AND DESIGNS IN EDUCATIONAL RESEARCH METHODS: A COMBINATION OF STRENGTHS AND WEAKNESSES

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Ever since its founding, the Pedagogy Department at the Complutense University of Madrid has considered statistics to be fundamental instrument in the training of educational researchers. For this reason, the department has made every effort for the teaching of statistics to keep pace with the field itself. However, the results so far have been unsatisfactory. These negative results, combined with Pedagogy students' initial limited ability in statistical processing, point out the need for new techniques that can be used to teach research methods in education.

BACKGROUND

In the 1950s statistics gradually became recognized as a tool that could be useful for research in pedagogy. The introduction of this tool was due in large part to the showiness of the results produced by investigations carried out using experimental psychology assumptions. In fact, this discipline gradually branched away from philosophy, the area in which it had originated, and constituted its own scientific field. Its growing independence became an incentive to some investigators in the pedagogic area to disengage themselves from the philosophical environment.

Pedagogic researchers also chose to employ statistical methods in order to improve the quality of their research results. However, this process was extremely slow and difficult. To start with, the number of investigators using statistics was very limited due to the assumptions implied by the application of this tool and to the overhelming effort that this required at that time. What's more, the new tool was difficult to apply in a literary-oriented investigating tradition.

Although about seventy years have passed since the introduction of statistics as a training resource for teachers, it is still difficult to apply to concepts more complex than a mere count of frequencies or proportions. In general, its structure exceeds the processing capacity of the average student seeking a degree in pedagogy.

THE PROBLEM

In recent decades there have been several attempts to adapt the pedagogy syllabi to the developmental level of the Spanish society (Plan 1993, 2000). In the framework of these adaptations, the academic authorities tried to maintain a difficult balance between the typical orientation of the Spanish universities, with an emphasis on transmitting essentially theoretical knowledge, and the need for a more practical focus that meets certain formative gaps. To this end, the traditional obsession for theory continues to a certain extent to eclipse the practical side.

Throughout the 1970s and 1980s, Prof. Víctor García Hoz (1911-1998) and his collaborators supervised teacher training in statistics and monitored its status. Under the names of Experimental Pedagogy I, Experimental Pedagogy II and Statistics Applied to Education, the contents were chosen with an eye to preparing future educators capable of reading and understanding the literature and results of investigations carried out under certain strict assumptions as well as participating actively in the laying out and execution of these investigations. In the mid-1980s Prof. Arturo de la Orden Hoz and his team not only surpassed but also improved upon the outcomes achieved by their predecessors. However, they noticed a problem that continues to occur: the previous knowledge of the students who intend to study pedagogy suffers from serious basic gaps; in general their previous training in logical-mathematical reasoning is quite weak.

In addition to these gaps most students seem to fear and strongly resist contents rejected a long time ago; the structure of the subject is frequently considered excessively rigid and complex. The consequence is a succession of large cohorts of educators who are capable of having a good - maybe superficial - command of the basic concepts of what it means to use statistics in investigations but who avoid using it once they have got their degrees.

IMPORTANCE FOR THE ADVANCMENT OF RESEARCH IN EDUCATION

The lack of explicit recognition by the highest educational authorities regarding the significance of training in research methods in education is reflected in its diminished presence in the 1993 and 2000 reforms: the contents taught in three courses in the previous syllabi are concentrated now in two intensive courses.

The Department of Methods of Research and Diagnosis in Education (Faculty of Education - UCM) is fully aware of the fact that progress in the Spanish educational research requires strong training in research methods; that is why it spends a lot of time looking for ways to make sure future educators are properly equipped with the most modern intellectual instruments. Fortunately this concern is shared by the Spanish universities that award a degree in pedagogy. At the same time, it is also generally recognized that a great number of Spanish students have serious difficulties when they have to work with the theoretical assumptions of quantitative oriented research, statistical calculations and interpretation of the results.

As the educational phenomenon is complex, it is logical to think that the techniques used for its study should be equally complex. Therefore it is essential that the students have a sufficient command of complex statistical techniques. This can be challenging as such techniques explain phenomena which are anything but simple.

We are certainly faced with a difficult problem: how to train potential researchers who have an aversion to sophisticated techniques based on logical-mathematical reasoning.

PREVIOUS EFFORTS

Until the mid-1980s the teaching of statistics focused heavily on trying to have students master handwritten statistical calculations related to simple hypothesis contrast. When the first personal computers appeared, Prof Arturo de la Orden Hoz and his team quickly incorporated this tool into teacher training (Figure 1 [dotted lines]).

However, this new step had two unexpected consequences: (a) the help the computer could offer was hampered by the inevitable computer science illiteracy of the time; in many cases the results that the computer provided took on an almost magic character; (b) For some students data processing practices were limited to following mechanically a sequence of non-significant orders issued by the assistants in the laboratory. The mechanical character of this activity was in direct disagreement with what the professor explained in the classroom. These problems still exist.

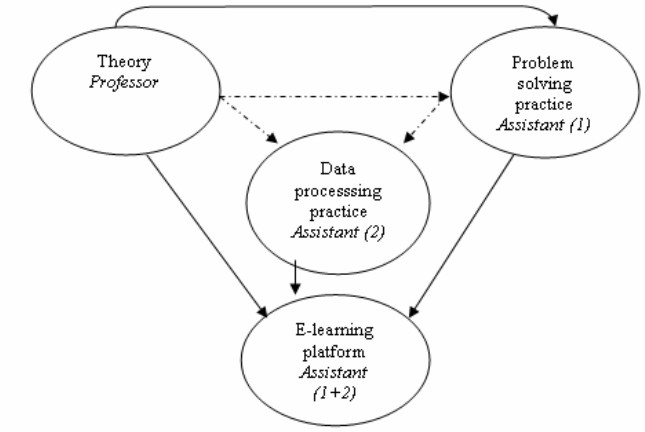

Figure 1: Coordination Classroom - Problem solving - Data processing

In order to maximize the coherence between the students' learning activities in their theoretical classes and in the data processing laboratory, it appears necessary to (a) set up a complex system of coordination, (b) design special data processing manuals for different levels of progress, and (c) train a numerous group of assistants for the data processing practices and for the resolution of practical problems.

SOME ACHIEVED OUTCOMES

One of the most noteworthy achievements of this effort has been the level of institutional acceptance of all these practices within the Faculty of Education. Difficulties are due partly to organizational rigidity of inflexible administrative structures and partly to some students' resistance.

In general students consider the contents related to research methods in education so difficult that a high percentage simply quits. Out of a natural group of 110 students registered in the 2004-05 academic course, 40 (36.4%) decided to take no exam at all and probably not even to participate in any learning activity. As for the rest, 13 (11.8%) took only the first of the two exams of the course before quitting; only 57 (51.8%) remained until the end. Of the latter only 17 (15%) showed a satisfactory command of the subject and 15 (14%) managed to pass with some difficulties.

The course consists of two parts. The first part is devoted to the theoretical basis of research methods in education and their peculiarities. This part also requires a reference to the problems of the causation, probability, sampling distribution and inference in social sciences. At the same time, a quick revision of descriptive statistics is made as a previous step to a first application of the concepts related to statistical inference. In the second part the students are trained in the hypothesis contrast and statistical tests applicable to simple designs of a maximum of three variables.

In this sytem, the theoretical explanations depend exclusively on the professor. In order to facilitate mastery of the complex process of hypothesis contrast, the Department organizes practical classes which complement the professor's theoretical explanations through the resolution of hypothetical practical problems. Trained assistants are in charge of these classes and carry out their task in close collaboration with the professor, who selects the exercises.

Table I: Descriptive data of the group

	Semester I		Semester II	
	Theory I	Practice I	Theory II	Practice II
Mean	5.32	6.54	4.62	6.80
SD	1.35	2.67	1.55	2.74
N	70	70	57	57

The study of the relationship between theory and problem solving suggests that the magnitude of the correlation tends to decline over the length of the course: while r_{xy} = .545 (p= .000) for the 70 students who took part in the first exam, it decreases drastically to r_{xy}= .248 (p= .063) for the 57 students who sat the second exam. Apparently as the course advances the students find it more and more difficult to relate the theoretical contents to the research designs and the ways of arriving at solutions to the problems under scrutiny. On the other hand, the differences in theory achievement between the two semesters are statistically significant. The differences in solving problems are not. Seemingly the students are more constant in their effort to master calculations, to the detriment of the theoretical basis. The results relating to theory are better in the first semester that in the second (Table II).

Table II: Theory and Practice

	Theory I-Practice I	Theory II-Practice II	Theory I-Theory II	Practice I-Practice II
t-test	-4.549	-5.895	3.814	1.512
n	70	57	57	57
p	.000	.000	.000	.0136

As for the effect due to the assistants' intervention, the difference in problem solving ability between the students attending practical classes and those who do not was statistically significant in both semesters: the former's achievement ($\overline{X}_{1^o} = 8.10$; $\overline{X}_{2^o} = 8.10$) is much better than the latter's ($\overline{X}_{1^o} = 5.91$; $\overline{X}_{2^o} = 6.19$) (Table III).

Table III: Problem solving effects

	t-test	n_1; n_2	p
Practice I	4.153	15; 55	.000
Practice II	3.224	12; 45	.002

EXPECTED IMPROVEMENTS

Another important tool that has just been incorporated is an e-learning platform; until now it has been used mainly as an accessible place where students can find their professor's original notes. This use seems to have no differential effect on achievement whatsoever: there are no statistically significant differences in theory (t=0.979, n=57, p=.332) nor in practical problems (t=0.004, n=57, p=.997) between the students who use the platform and those who do not. Repeating the subject has a similar effect on theory (t=-0.307, n=57, p=.760) as well as on solving practical problems (t=-0.813, n=57, p=.420).

In order to meet the needs of the ongoing incorporation of Spain into the European Space of Higher Education, the results achieved until now need to be improved upon. That is why it is necessary to optimize the students' learning conditions. The solutions envisaged until now show that when there is a profound involvement of the students in their own learning, through problem solving practices, for example, their outcome improves. Nowadays, the high dropout and failure rates in this subject show that the teaching is not efficient. In order to improve the results the search for solutions implies a process of gathering and analyzing students' data with relation to (a) their level of previous knowledge, (b) their attitude towards the subject, (c) their perceived level of difficulty of the subject. It also implies designing and testing new differentiated teaching methods, for example (a) control group: only attendance, (b) experimental group I: attendance plus practices to solve practical problems, (c) experimental group II: attendance plus learning through the e-learning platform, and experimental group III: attendance plus practices to solve practical problems through tasks based on the e-learning platform (Figure 1[continuous lines]).

The evaluation of the results can be carried out through an analysis of covariance in order to study the effect of the previous knowledge. An analysis of variance for non randomized, unbalanced groups can be useful to find out the relevance of the level of difficulty and/or of willingness to get involved in research methods in education. The results may point out the kind of improvements needed in teaching statistics to students seeking a degree in pedagogy.

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