

Teaching Quantitative Methods to Primary Schoolteachers

Insegnare Metodi Quantitativi ad Insegnanti di Scuola Primaria

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Riassunto: Il problema della diffusione della cultura scientifica trova nella formazione degli insegnanti dei vari gradi dell'istruzione un suo punto nevralgico. Il lavoro analizza attraverso dati di natura sia oggettiva che soggettiva il livello di competenza in questo ambito culturale e la propensione verso varie discipline tra gli studenti che stanno formandosi per divenire insegnanti di scuola primaria. Tra di loro tali competenze sono presenti in misura differenziata, ma ciò che appare più preoccupante è il diffuso atteggiamento negativo nei confronti dei metodi quantitativi.

Keywords: Teachers, Scientific Knowledge, Multidimensional Scaling

1. The problem of the spread of scientific knowledge

Both Italian (Invalsi, 2005) and international (Mullis et al., 2003) studies have shown that Italy certainly does not occupy a primary position in knowledge of scientific and mathematical subjects, and that there is a worsening trend passing from lower to higher education. This is worrying, both for the Italian educational system and in view of the demand for new professional figures in contemporary society: Italian law 53/2003, reforming the educational system, recommends that one of the aims of primary school is “to lay proper bases for the exploitation of scientific methods in the study of the natural world, its phenomena and its laws”. This is an attempt (which may be criticised from some standpoints) to respond to the new demands dictated by society. In particular, recommendations covering the teaching and learning of mathematics emphasises how some form of knowledge should be developed in students which, starting from data on perception and experiences, leads to their rational organisation. It is significant that, together with the classical learning aims covering the concepts of *number*, *geometry* and *measurement*, an *introduction to rational thought* and *data and predictions* are also mentioned. In order to achieve the above objectives, the capacity to reason and to pose and solve problems, i.e., the typical procedures of thinking and of scientific method - since they are specific competences - should be developed.

2. Teacher training

At school, students acquire knowledge and competences by means of various strategies on the part of their teachers. However, no-one can teach anyone anything without personal knowledge and experience of the subject matter. If a concept is not personalised, there is no way in which significant learning can be achieved, and this highlights the

fundamental role played by teachers and their own training. In spite of the proliferation of other cultural mediators due to new technologies, teachers continue to be the essential key to the spread of knowledge, including scientific knowledge, and they have the responsibility of introducing students to that knowledge and of communicating to them their own passionate interest in research and discovery.

In Italy, in order to teach in primary schools, applicants for teaching posts must have a specific degree (required since 1998). The posts available are established annually by a ministerial decree, and a compulsory admission test is given. Analysis of the university careers of applicants to this type of course (cfr. Amplatz and Clerici, 2005) has shown that a certain number of applicants have real difficulty in passing examinations in the scientific and methodological fields. With the aim of collecting both objective and subjective information on applicants' attitudes towards preparing for the teaching profession in the methodological disciplines, a study was carried out in 2005 on second-year students attending primary teacher training courses at the University of Padua. Of these, 129 who stated that they had received no university training were selected. The data analysed in the following sections thus deal with would-be teacher trainees who enrolled immediately after obtaining their high school diplomas, and are taken from three different, interconnected, sources of information: the results of the admission test, university archive data, and a self-report questionnaire.

3. Some results

a) Objective aspects. The test for admission to teacher training degree courses contains one section of questions concerning scientific and mathematical knowledge, and aims at ascertaining basic concepts acquired in the fields of Biology, Chemistry, Physics, Earth Sciences and Mathematics. Analysis of scores shows a strong tendency towards normal distribution, values mainly plotting around 9/20 (and $\sigma=3.5$). Without knowing the standardisation of the test, we can only comment on these results by referring to the study group, which contains many subjects whose knowledge of the above basics is "weak". These results are significantly correlated with the overall results of the admission test ($\rho=0.81$; sign. <0.01), again not particularly brilliant ($\mu=37/80$, $\sigma=9.2$), and with the mean of the first-year examinations ($\rho=0.35$; sign. <0.01). As regards trainees with high school diplomas, scores were around 76/100, but a considerable number of students (11%) had obtained their diplomas with the minimum score.

b) Subjective aspects. In a self-report questionnaire, would-be trainees were asked to express their attitude towards various subjects in the curriculum.

One of the questions asked for an evaluation, on a self-anchored scale, from a minimum of 1 to a maximum of 6, of trainees' feeling "particularly suited" for each of a set of disciplines, and responses were analysed by means of a multidimensional scaling procedure (Fabbris, 1997). The ALSCAL (*Alternative Leastsquare SCALing*) procedure, implemented in SPSS 12.0, highlighted the dissimilarities between the attitudes expressed by future teachers. Their positions on the first two dimensions extracted (fit measure: Kurskal's *Stress* = 0.151; proportion of variance: $RSQ=0.893$) identified a group of disciplines which trainees perceived as similar to each other (Figure 1), and highlighted the clearcut difference between applicants' preferences, which systematically favoured humanistic studies.

Figure 1: Two dimension perceptive map

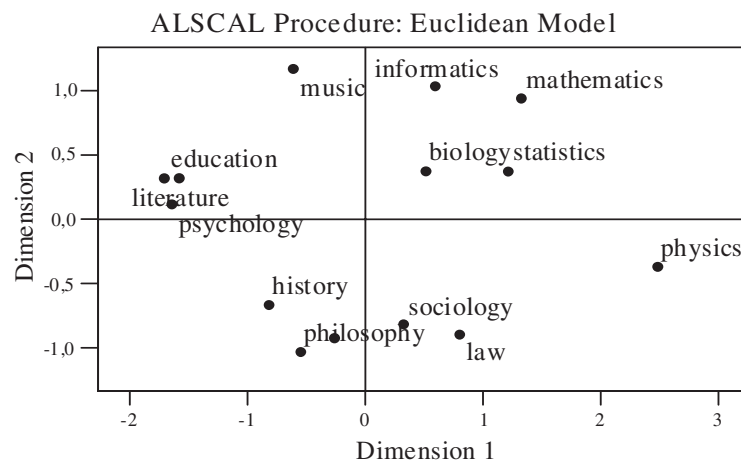
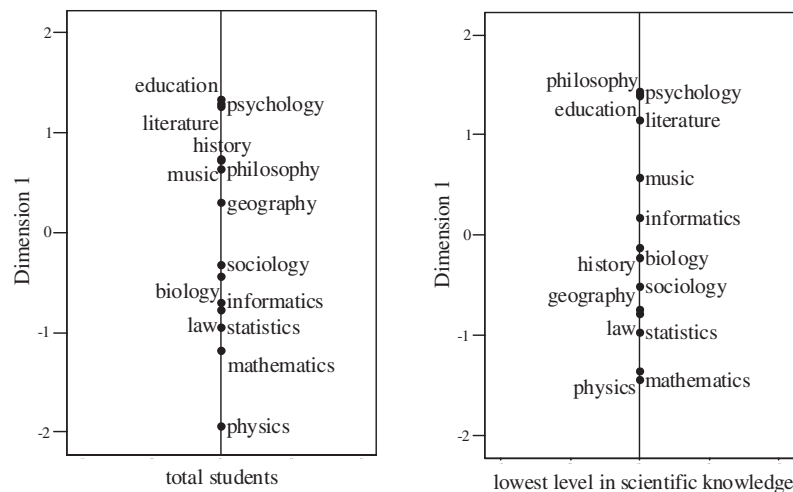


Figure 2: One dimension perceptive map: total students vs students with lowest level in scientific knowledge



Comparing the scaling results among trainee groups classified according to scientific knowledge, we see that positions with respect to expressed preferences do not change in any substantial way. For example, Figure 2 shows comparisons between preferences expressed by all students and those of the group which scored lowest on the admission test (under $\mu - 3/2\sigma$).

The analysis should be worked out in a multivariate perspective (Bronstein et al. 2006) to verify the effect of some individual characteristics on perceptive maps. Gender shouldn't be considered because women represent 99% of the sample, while the type of school could be an important factor of variability to take into account.

One of the subsequent questions asked students to associate the word which best expressed their attitude towards each of the subjects. The “difficult” scientific disciplines (physics in particular, but also mathematics and statistics) aroused less than half the *interest* shown in humanistic disciplines (literature, music, education, history, etc.). The former disciplines were generally associated with *worry* and *fear*, or in any case with a certain *diffidence*; several students even stated that they felt *repulsion*. Too small a

number of students expressed a definitely positive attitude towards them. Table 1, applying the standardised residues method (cfr. Diamond and Jefferies, 2002), shows the links of attraction and repulsion between attitudes and some subjects in the training curriculum, both humanistic and scientific.

Table 1: *Associations between attitudes and some subjects in training curriculum*

ATTITUDES	SUBJECTS						
	Mathematics	Physics	Statistics	Philosophy	Literature	Education	Music
Repulsion	1.88	6.70	-1.75	1.52	-2.72	0	-2.75
Fear	5.85	6.43	6.48	-1.61	0	0	-1.97
Diffidence	0.29	1.35	2.12	1.01	0	0	-1.97
Worry	3.87	6.32	8.27	-2.20	0	0	0
Indifference	-0.50	0.68	-1.78	-1.53	-3.00	-3.77	-0.81
Interest	-2.82	-4.50	-0.51	1.41	0.97	2.73	-2.53
Attraction	-1.55	-3.20	-1.84	-3.53	-1.01	0.58	0.01
Pleasure	-1.44	-3.98	-3.96	0.79	6.74	2.83	7.07
Passionate Interest	-1.85	0	0	0.51	4.42	6.17	4.63

Values outside interval of ± 1.96 : significant association (of attraction or repulsion) between stated attitude and discipline in question.

A marked lack of confidence in one's own capacities in the quantitative sphere is thus widespread among future teachers. This extremely worrying signal indicates that trainees feel they are not suited to transmit knowledge and true interest in quantitative disciplines to their future pupils.

These attitudes did not seem to be due to any particular characteristics of the would-be trainees: neither the type of school they came from, nor good final diploma results, nor those of the admission test were significantly associated with the analysed attitudes.

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