THE TRANSITION FROM UNIVERSITY TO WORK: A CASE STUDY

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Teaching statistics to future statisticians should take into account both statistical knowledge and personal skills needed in the statisticians' professional life. Based on a questionnaire designed to assess competencies actually needed by statisticians in the workplace, this paper aims to detect if the competence framework helps to better understand the transition from university to work. With this objective, three metric profiles are proposed to locate knowledge, "relational skills" and actually performed activities, and graduate scores.

The graduates in Statistical Sciences from "Sapienza" University of Rome from March 2000 to March 2001 were acquired as emblematic cases in Spring 2004. There were 146 respondents out of the total of 296 graduates in the time period. The Rasch analysis is applied to analyze the data and to build on the profiles. In particular the analysis was performed applying the Rasch family response models to polytomous items. The item parameters and the latent trait value for each respondent are estimated by the joint maximum likelihood method.

The analysis results could be useful in order to design curricula for university degrees in Statistics that would make the university-workplace transition process easier.

INTRODUCTION

Transitioning from a university to the workplace involves three factors: the university system, the workplace, and the student/graduate. However, in studies on university-workplace transitions, these elements are usually joined in a way that only two roles are active: the one of the university and the one of the workplace. This is easy to see in sentences like: the teaching of a discipline at the university level has to be informed, at least in part, by what graduates will have to do with their acquired knowledge in their respective fields of occupation after graduation. The graduate role comes into view when the concept and methods of competencies (Ajello, 2002) are introduced. Within this framework, university system and workplace interact through the student/graduate, a kind of Janus, the Roman god of passages depicted with two heads, facing the past and the future. In fact, the student/graduate has personal traits, qualities, abilities, and skills through which acquired knowledge is transferred from the university to the current job and then adapted to workplace needs. The student/graduate is the motor of this transformation process. He/she has some qualities that may also be educated and trained and that workplace is interested in, particularly communication skills, decision making skills, and interpersonal skills.

With reference to statistics, especially when a constructivist pedagogic approach is utilized, teaching/learning of the subject enlightens communication skills and decision making skills – in particular problem solving –, and facilitates the development of interpersonal skills through cooperative-learning didactic strategies. Therefore, Ottaviani (2004) has proposed to take into account the concept and method of competencies in order to investigate transition from the university to the workplace from the graduates' point of view. In consequence, competencies have been the basis on which to build a questionnaire to assess professional knowledge and skills that statisticians actually need in the workplace. The graduates in Statistical Sciences[2] from "Sapienza" University of Rome from March 2000 to March 2001 were studied three years after graduation (Aureli & Ottaviani, 2005). In that instance, however, only the use of statistical knowledge and the workplace needs of statistical activities have been analyzed.

In this paper we propose to utilize the data already collected to create three metric scales that will assess graduates: subject knowledge use, relational skill needs, and statistical activities and information technology use in their current job, in order to assess if the competence

framework helps to better understand this transition period. It is in fact a delicate one, where the graduates have to utilize their knowledge background in order to face workplace needs while taking into account relational skills needed to perform their current job.

THE STUDY

The target population of this survey comprises 296 graduates of the Faculty of Statistical Sciences, classified according to four different specialties: 71 graduates in Statistical and Socio-Demographic Sciences (SSDS), 178 graduates in Statistical and Economics Sciences (SSE), 44 graduates in Statistical and Actuarial Sciences (SSA), and 3 graduates in Statistics. As previously stated, all of them received their degree between March 2000 and March 2001.

The data were collected through the CATI method (Computer Assisted Telephone Interviewing). The telephone interviews were completed in the period May, 20 – July 21, 2004, so that all of the respondents had completed their degree about three years earlier. This is the period utilized by Istat (Italian national statistical office) in surveys concerning the transition from university to work, as it is suggested that three years may be long enough for a graduate to get a job, but not so long that he/she forgets what he/she was taught at the university.

The developed questionnaire has 40 questions and was organized in an electronic form suitable for CATI. All the items requiring interviewed opinions utilize a four level Likert scale, from “very important” (1) to “not important” (4).

The questionnaire begins with a “filter” question separating respondents who have or do not have a job. Then it continues by asking employed graduates what kind of occupation they have and at which level (clerk, technician, professional). The questionnaire continues by asking if employed graduates are utilizing the subjects they were taught by the Faculty of Statistical Sciences and at which level on the Likert scale. Next the questionnaire asks about the level of utilization of personal and inter-personal skills, particularly communication skills, working with others in groups, posing and solving problems, and undertaking decisions. We have called these “relational skills.” This set of questions is based on the O*Net questionnaire. The following group of questions concerns the level of utilization of a list of statistical activities, as well as the level of the use of information technology. The statistical activities considered cover the entire statistical process, from the problem to be solved through the planning of the research, the data collection and analysis to results, conclusion, and their utilization. The last questions concern the job sector (private or public) and the name of the firm where the graduate is employed. Personal data: gender, specialty, and grade (from 67 to 110), were received from the student secretary of the Faculty.

A total of 146 graduates were interviewed by phone, the number of those who refused the interview was irrelevant. The effective response rate was 49%, which is good for this kind of inquiry, and it is important to notice that the distribution of the respondents by specialty is similar to that of the target population.

THE METHODOLOGY OF THE ANALYSIS

The aim of this paper is to measure the three different elements in the competence theory; it has been suggested to perform the Rasch analysis on the collected data. In this context, in fact, the Rasch analysis seems to be a suitable methodology because it permits us to define comparable metric scales on which it is possible to locate both the items (profile constituents) and the respondents (Harraway & Andrade, 2006). In particular, the Rasch analysis allows understanding of the relevance of each profile constituent by posing each item on the metric scale. Likewise, the individual location on the scale permits us to evaluate his or her relative position as to the studied profile.

In this study the items of the questionnaire have polychotomous answers that, as was already said, have been assessed by using the main principles of the Likert scale in which each graduate is required to assign a response on the agree-disagree continuum.

The analysis of responses collected on a Likert scale may be conducted by using the rating scale model (RSM) which is a latent structure model for polytomous answers to a group of test items. The RSM belongs to the Rasch family models and shares the main features with these models. As a special case of the polytomous model presented by Rasch, the RSM was

reconstructed as a rating scale model by Andrich (1978). The RSM allows us to consider the answers as ordinal data and it transforms the count of the endorsement of the ordered Likert *m* categories into an interval scale.

The main characteristics of the model can be described as follows. If we consider a test of *n* polychotomous items, the responses on test item i ($i = 1, 2, \ldots, n$) can be represented by the variable U_i that can take the values $h = 1, \ldots, m$, so that the response functions are given by

$$P_{ih}(\theta) = P(U_i = h \mid \theta) = \frac{\exp[w_h\theta - a_i - a_{ih}]}{1 + \exp[w_h\theta - a_i - a_{ih}]}$$

where θ is the latent trait that determines the response function and $w_1, \ldots, w_m$ are the category scores, which indicate how the *m* response categories are scored. The a_{ih} are item parameters connected with the categories of each question and a_i is the endorsability of the entire item, usually called *item difficulty*.

Typically, item parameters a_{ih} are estimated by joint maximum likelihood. In this work, all calculations are carried out using the software WINSTEPS (Linacre & Wright, 2000).

In general, the RSM permits us to estimate the *difficulty* of each item and the thresholds between the different categories. If an item shows a high difficulty level, it means that the respondent must have a high value of the latent trait to endorse that item. In this context the meaning of the difficulty parameters is slightly different because the studied latent trait defines a profile. Therefore, the values of the parameters indicate the level of a profile constituent, which is an item, on the metric scale. In particular, a high value of the difficulty parameter indicates that the corresponding item describes a high level of the latent trait depicted by the questionnaire, while a low level of that parameter indicates a low level of the considered trait.

It is also worthwhile to note that the Rasch analysis has to take into account not only the item difficulty and respondent estimation of the latent trait; it is also crucial to consider the important issue of item fit and respondent fit. The WINSTEPS software provides a wide variety of output formats that are indispensable for investigating rating scale quality. Through these outputs the capability of each item and of each respondent to fit the data may be taken into account (Bond & Fox, 2001).

THE ANALYSIS OF THE RESULTS

The RSM was applied to analyze the opinions of the 133 employed respondents. Included in the number were also the few engaged in Doctorate Research.

Three profiles were identified with reference to the current job performed by the interviewed graduates: the utilized university subjects, the “relational skills” needed, and the statistical activities and information technology used (Table 1). The profile of university subjects that were actually utilized sets the core curriculum disciplines in a statistics degree: mathematics, statistics, and probability, against substantive application fields, particularly: finance, demography, insurance, and social statistics, with the exception of economy and econometrics that are located near the core curriculum subjects. The profile of the “relational skills” needed to perform the current job sets “low level skills” suitable for group members like active listening, getting group members to work together to accomplish a task, and analyzing data or information to solve problems posed by others – against “high level skills” suitable for group leaders and researchers such as: utilizing reports and documents written by others, critically identifying weakness and strength of solutions, and identifying training needs of others. The third profile sets in a continuum the utilization of ICT as well as of statistical activities actually performed by the interviewed graduates. On the scale, the ICT use is set against the stock market analysis. In the positive scale there are the statistical activities more concerned with data collection and operational statistical activities, while in the negative scale there are designing research and methodological issues, along with financial and insurance activities.

The RSM method allows us to locate graduates on each profile according to their replies to the correspondent constituent items. Two characteristics have been considered that may affect

an individual score: the employment field (research, civil service, banks and insurances, tertiary sector, and industry including ICT) and the specialty degree of the graduates (SSA, SSE, SSDS and Statistics).

Figure 1 shows the box-plot distributions of scores on each of the three profiles by graduates' employment field. Graduates in research fields generally intensively utilize the core disciplines of statistics, probability, and mathematics as well as the applied fields of economy, demography, and finance and insurance. Their knowledge is used to perform research activities both in the theory and in the application of statistics, in addition to pointing out the need of high level relational skills in their current activity. Civil servant employees generally utilize computer science and core statistical subject to perform data collection, organize databases, and perform operational statistical activities more than applying themselves to methodological issues. They also show the need for high level relational skills in their current job. The graduates that are employed in banks and insurances generally utilize computer science and the core statistical subjects, as well as economy and finance, to perform both methodological issues and financial and insurance activities. They also see collecting data and performing operational statistical activities as important actions. Besides this, they recognize the need for high level relational skills and low level relational skills in their current job. The graduates in the tertiary sector utilize computer science at a very important level. Core statistical subjects, finance, and demography are used to perform activities that are balanced among data collection and methodological issues which point out the importance of high level relational skills, particularly problem solving and making decisions. In industry, computer science use is very important along with the use of the core subjects. These graduates generally utilize ICT at very important level, to organize data bases and to design research. They exhibit the need for certain high level skills, such as writing documents for others, problem solving, and decision making skills.

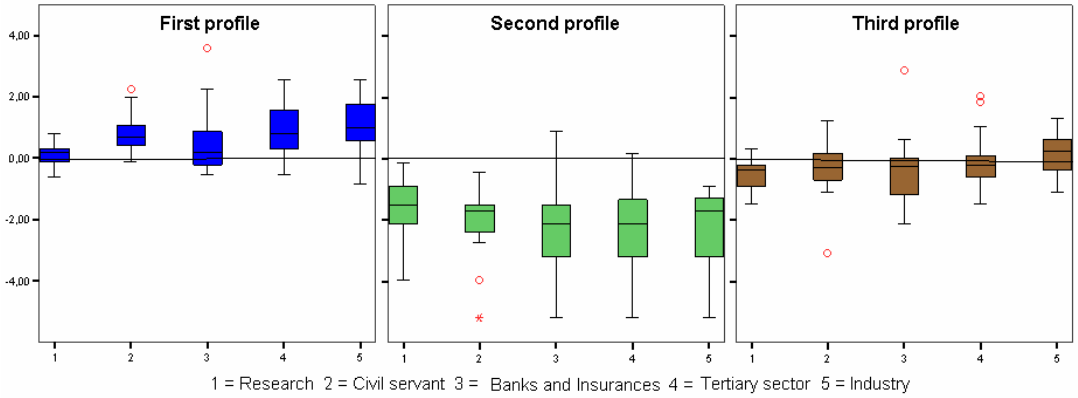

Figure 1: Graduates' scores by profile and employment sector

Table 1:
Item parameters for each skill scale[3]

First profile: Actually utilised university subjects		Second profile: "Relational skills" needed		Third profile: Statistical activities actually performed	
Items	a_i	Items	a_i	Items	a_i
Computer Science	2.26	Active listening	0.66	Using ICT	1.44
Mathematics	1.26	Getting group members to work together to accomplish a task	0.66	Utilising already existing technical reports and documents	0.83
Statistics	1.03	Communicating with supervisors, peers or subordinates	0.56	Writing technical reports and documents	0.82
Economy	0.56	Analysing data or information to solve problems posed by others	0.47	Organising data base	0.58
Probability	0.17	Encouraging and building mutual trust, respect and cooperation among team members	0.44	Utilising data for evaluation	0.44
Econometrics	0.07	Identifying and posing problems	0.44	Utilizing data for descriptive goals	0.43
Finance	-0.21	Scheduling his/her own activities and work	0.17	Searching for statistical data and information sources	0.24
Demography	-0.51	Training and teaching others	-0.12	Collecting data	0.23
Insurance	-0.74	Directing and motivating subordinates	-0.32	Utilising data for management goals	0.12
Social Statistics	-0.83	Writing reports and documents to be utilised by others	-0.49	Utilising data for forecasting	0.12
Operational Research	-0.88	Identifying training needs of others	-0.49	Utilising data for scheduling industrial or service production	0.07
Law	-0.95	Making decisions and solving problems	-0.59	Designing research	-0.08
Sociology	-1.22	Critically identifying weakness and strength of solutions	-0.65	Choosing among suitable existing methods	-0.34
		Utilising reports and documents written by others	-0.73	Searching for new statistical methods and tools suitable for his/her one activity context	-0.41
				Checking financial situation	-1.24
				Building on insurance or financial contracts	-1.55
				Analysing the stock market	-1.70

The distributions of the graduate scores by statistics degree (Figure 2[4]) show that the SSA graduates generally have a smaller set of subjects actually used in their current job. Their important activities concern finance and insurance, as well as the need for high level relational skills. The SSDS graduates seem to utilize all the subjects, from computer science to demography, in order to perform statistical activities which include collecting data, designing research, and finding new statistical methods. There are many relational skills that are pointed out as needed in the current job by these graduates. In fact, the SSDS group are the least specialized among graduates. The SSE graduates fall between the SSA and SSDS graduates. They intensively use economics and econometrics subjects, perform activities in equilibrium among data collection and methodological issues, and indicate the importance of high level relational skills.

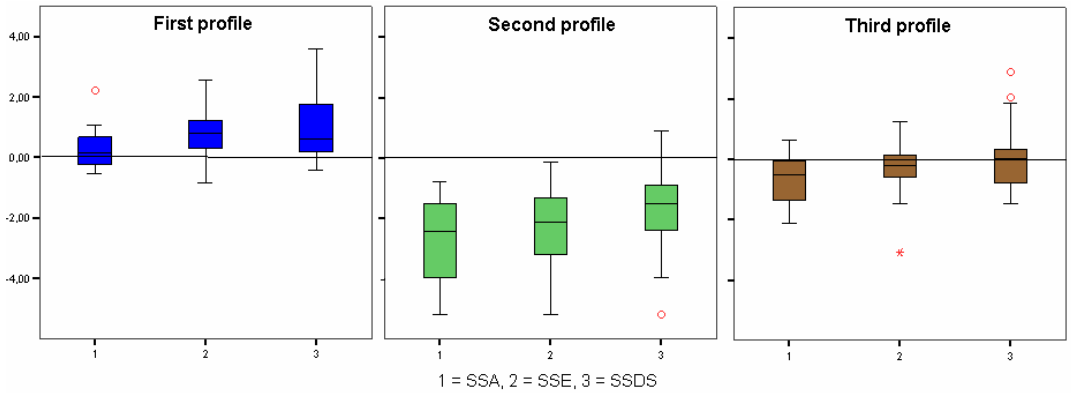

Figure 2: Graduates' scores by profile and degree specialty

CONCLUSION

The preceding results show that young graduates in Statistical Sciences at "Sapienza" University of Rome actually acknowledged the needs for communication, decision making, and interpersonal skills in their current job. In consequence, as university teachers we need to not only identify the subject knowledge, but also to facilitate the development of the students/graduates' competencies required by the workplace in this historical moment. As statisticians, we are favoured in attaining this aim because problem solving is prevalent in statistics and the discipline also enlightens communication skills and working in groups.

NOTES

[1]Paper funded by 2005 funds of the Faculty of Statistical Sciences of "Sapienza" University of Rome, Italy.

[2]In Italy, thanks to Prof. C. Gini, the Faculty of Statistical Sciences was built on in 1935 with the four year degree in Statistics and Actuarial Sciences and in Statistics and Demographic Sciences. The four year degree in Statistics and Economics Sciences was added in 1981, and the one in Statistics in 1997. From 2001 all this changed according to a new reform law, but these fundamental streams still remain.

[3]The standardized infit values for each item are in the range of -2 to +2 that are usually held acceptable in the Rasch analysis literature.

[4]Because of their small number the graduates in Statistics have not been shown in this figure.

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