



UNIVERSITAT POLITÈCNICA
DE CATALUNYA

Advising on academic quality: reading with numbers

María Inés Herrera and Cecilio Mar Molinero

IOC-DT-P-2004-02
Ferbrer 2004



ADVISING ON ACADEMIC QUALITY: READING WITH NUMBERS

María Inés Herrera
Facultad de Ciencias Exactas
Universidad Nacional de Río Cuarto (Argentina)
maria.ines@upc.es

and

Cecilio Mar Molinero
Institut d'Organització i Control de Sistemes Industrials
Universitat Politècnica de Catalunya (Spain)
cecilio.mar@upc.es

This version January 2004

ABSTRACT

Degree validation is a delicate business. Validation teams have to ensure that the institution or the degree being validated meets academic quality standards. Often this means standards in two different countries with different traditions. This paper describes how the qualitative information contained in a validation document was translated into a set of variables and analysed using multivariate statistical methods. The methods employed had to be transparent to the institution being validated and to other members of the validation team, and had to form the basis for a qualitative discussion and for a set of recommendations. The tools employed are based on multidimensional scaling, cluster analysis, and multiple regression methods, all of them resulting in graphical representations. The paper illustrates the use of quantitative tools in a qualitative way. Operational Research tools are used as a way of facilitating the analysis and decision process.

Keywords: Academic Quality Control, Multivariate Statistics, Educational Assessment, Multidimensional Scaling.

Running Head: Assessing academic quality.

INTRODUCTION

Academic quality concerns governments, universities, and students. This is particularly true in the case of validated degrees, often involving two different countries with different academic traditions. Validation implies that the validating institution guarantees, for a fee, that the degrees awarded by the validated institution meet the quality standards of the validating institution. The degree awarded to students of the validated institution is, at least in theory, no different in quality from the same degree awarded to other students of the validating institution. Validated degrees carry the name of the validating institution but are obtained after successful completion of a programme of study in the validated institution.

Validation suits the purposes of both the validated and the validating institution. At the most basic level, there is a commercial transaction: the validating institution receives an income. The validated institution gains credibility and becomes attractive to future students.

The need to be validated is often a consequence of academic legislation. Not everyone can award degrees. For example, both in the UK and in Spain, very strict conditions have to be met by a degree awarding institution. Such conditions relate, amongst other things, to staff qualifications and number, minimum number of degrees awarded, breadth of study, facilities, and premises. A small institution, however good it might be, is unlikely to be approved as a degree awarding body in its own right. Validation is then used as a seal of approval, as a certificate of having met a benchmark. The case of an independent business school that has developed a good reputation in a particular area of expertise, and uses validation as a show of public acknowledgement for the quality of its studies is a fairly standard one. A non-EU university seeking to establish a foothold in the EU may, in the first instance, see validation by an EU institution as the way forward.

The validating institution may have strategic objectives in the validation process. It may see validated degrees as a source of potential research students, or it may be trying to control potential future competitors, or it may simply aim at developing a presence in a different country or region. The validated institution may also have strategic objectives, such as developing a reputation as a first step in the process of eventually becoming a fully recognised independent degree awarding body in its own right. The validated institution is, in a sense, buying reputation and future potential growth. Apart from the money, it has little to lose in the validation process. This is not necessarily the case with the validating institution, whose reputation loss if things go wrong can be disastrous. Therefore, established universities have very strict regulations on how validation should take place. For example, [give example of Wales if it is open access](#).

Governments take an interest in the validation process. The reputation of academic studies both in the country and abroad is an important intangible national asset that needs to be audited. Official bodies, such as the Quality Assurance Agency (QAA) in the UK, and its equivalent body in Spain, ANECA, ensure that standards are maintained and that procedures are followed. The reports of the QAA are published in the Internet.

Validation requests take place all the time, and standard procedures are in place to deal with them. These, in essence, require the institution making the request to prove that it has enough well-qualified staff; that teaching- including syllabuses- meets the necessary standards; that it has the necessary resources such as library, computers, software, and other equipment; that premises are appropriate for the purpose; and that its administrative procedures, including student admissions, examinations, and appeals are satisfactory. Normally, the institution making the request prepares documentation dealing with all the above points. A committee of the validating institution studies

this documentation. The validation committee makes a recommendation on the way the request should be treated. The documentation tends to be voluminous, complex, and contains a mass of detail. Clearly, an analytical methodology that highlights the main points of the request facilitates decision-making and can be of great importance as a decision tool.

This paper describes the way in which some of the tools of multivariate statistical analysis were used in order to translate the documentation submitted by an institution seeking validation, into a set of maps that highlighted some strong and weak points in the request. The use of statistical techniques based on data visualisation proved to be particularly helpful in the particular case described, which relates to a non-EU organisation already established in the EU which was seeking validation from a UK university. The methodology described here can be of general interest in other situations.

The paper first describes the validation process in place in this particular case, and the documentation on which the discussion was based. This is followed by a discussion of the way in which some of the qualitative information in the document was translated into observations on a set of variables. The analysis section follows and describes the way in which multidimensional scaling, multiple regression, and cluster analysis were combined to create a decision support tool. The findings of the analysis are discussed next. The paper ends with a concluding section.

THE CASE STUDY

The Institute for Advanced Management Studies (IFAMS) -not the real name-, already established in the EU, and awarding degrees not recognised in the EU, was planning an expansion. As a first step, IFAMS had rented premises and access to facilities in a well-respected EU university, the

University of Propodas (UOP) –not the real name. By virtue of this agreement, students enrolled in IFAMS had access to the computers, library and sport facilities at UOP. UOP had spare capacity, and the agreement with IFAMS offered a way of not wasting it. IFAMS students came mainly from non-EU countries and could have never been accepted by UOP without a substantial amount of bureaucracy. IFAMS approached a UK university, the University of Hampshire (UHS) –not the real name-, for validation. Given the international outlook of UOP, and the reputation of UK universities, this was seen as a way of both showing that the studies offered by IFAMS were of high quality, that good quality facilities were available to students, and as a good marketing point to attract future students. Thus, the study involves the validating university, UHS, the institution seeking validation, IFAMS, and the university that hosts the premises, UOP. Neither UOP nor IFAMS were in the UK.

UHS administrators dealt with the validation request in the first instance. They visited IFAMS and gave advice on how a validation document should be prepared. This preliminary visit is also an initial quality test. UHS administrators may stop the validation process at an initial stage if there is no hope of it ever succeeding. Under the direction of UHS administrators, IFAMS staff prepared a document to be discussed by a validation committee. This committee contained UHS academics with an expertise in the studies to be validated; senior UHS academics with knowledge of academic issues; at least one academic from outside UHS and IFAMS with expertise in the studies to be validated: and UHS administrators. The validation committee read the validation document, visited IFAMS, and prepared a recommendation. The validation visit served to audit the information in the document, and to obtain new relevant evidence. The decision to accept or deny the request was taken by the Senate of UHS.

The document sent to members of the validation document contained much information. Given that UHS was a UK university but IFAMS operated outside the UK, it started with a discussion of the education system in place in the country where IFAMS operated and the way in which it differed from the UK system. Aims, objectives, and philosophy of IFAMS were next addressed. Administrative arrangements covering student admissions, syllabus design, academic quality control, internal organisation, examinations, and discipline formed another section. The main body of the document discussed degree structure, and contained the syllabuses of individual subjects. In fact, for each subject, the document named the staff involved; gave the syllabus- including bibliography-; and described assessment methods. A final section of the document contained the CVs of all the members of staff involved in the teaching process. This document formed the basis of the discussion between the validation committee and members of IFAMS, and the recommendations made by the validation team were based mainly on the evidence presented in this document.

The questions that the validation committee had to address are more or less as follows. Is the structure of degrees offered by IFAMS satisfactory? Are individual courses of sufficient standard, and is there progression as the degree develops? Does IFAMS have sufficient and appropriately qualified staff to deliver the curriculum? Are admissions, assessment, and disciplinary procedures appropriate? Does IFAMS have the necessary infrastructure –including computers, software, and library- to support degree level studies? Are administrative procedures in place at IFAMS compatible with administrative procedures in place at UHS? These are obvious questions to address in a validation visit, and staff at IFAMS knew it. The validation document had been prepared with these issues in mind. Clearly, it contained too much information that needed to be summarised, organised, and presented in a way that would facilitate discussions. The method in which this was done is described next.

THE DATA USED IN THE MODEL

Considering that staff is the most important asset at any university, a database was created in SPSS in which each member of staff was treated as an observation. Given that IFAMS had not been operating for long, and that it only offered a small number of degrees, only sixteen members of staff were named in the validation document. For the purposes of this study, measurements were taken on ten variables. Each member of staff was treated as a case. Some of the variables were measured on an ordinal scale, others were measured on a ratio scale ([reference](#)). The variables were:

1. Maximum qualification level (DEGREE) coded as follows: PhD was allocated 5 points; a person who was studying for a PhD and had completed the research training stage was allocated 4 points; postgraduate studies such as an MSc or MBA were allocated 3 points; a degree was allocated 2 points; other qualifications were allocated 1 point.
2. Number of years of research experience (EXPIN).
3. Number of years teaching experience (TEACHY).
4. Type of teaching experience (PRIOR) coded as follows: lecturing with a permanent contract at a State university, 5 points; lecturing at a private university, 4 points- this was done because procedures to obtain a permanent post at a State university in the country where IFAMS operates are very strict, while procedures to teach at a private university are less demanding; teaching at a State university as teaching fellow, 3 points; teaching at an official, non-degree institution, 2 points; other teaching experience at lower level, 1 point.
5. Quality of best publication (PUBLICAT) coded as follows: paper in an internationally recognised academic journal, 5 points; paper in a nationally recognised academic journal, 4

points; conference papers or internal research papers, 3 points; newspaper type publications, 2 points; no publications, 1 point.

6. Number of international publications (NOINT).
7. Number of national publications (NONAT).
8. Highest level of professional experience achieved (PROFEX): managing director, 5 points; consulting, 4 points; intermediate management level, 3 points; low responsibility managerial jobs, 2 points; no professional experience, 1 point.
9. Number of training seminars attended (SEMATTE).
10. Number of training seminars given (SEMGIVEN).

A university engages in teaching and research. Since UHS was a major research institution, the research ability of members of IFAMS was considered to be important. Being in possession of a PhD, or being in the process of obtaining one, is important, and this is measured by DEGREE. But having the qualification is not all; the proof of research ability is the production of research papers in academic journals, something that is measured by variables PUBLICAT, NOINT and NONAT. In order to put the publication record in perspective, one needs to take into account the number of years of research experience, something that is measured by variable EXPIN. Teaching experience is important when assessing a teaching institution, and the level at which such experience had been obtained, TEACHY and PRIOR were defined with this in mind. IFAMS specialised in management studies, and for this reason having industrial experience was also considered important and measured by variable PROFEX. Finally, keeping up to date in the pursuit of knowledge defined the last two variables. SEMATTE measured the willingness to learn. Being able to train requires being one step ahead of standard knowledge, and this was measured by SEMGIVEN.

Data was obtained from CVs. This has limitations. CVs were not standardised. Each individual had written his/her CV according to his/her own criteria. It is possible that some relevant information might not have been entered, and that variables might have been observed with error, but one would expect a league table of individuals based on the above variables would rank them in the correct order. This observation suggested that analysis methods based on orderings, such as Multidimensional Scaling (MDS), should be preferred to analysis methods based on actual measurements, such as, for example, Principal Components Analysis (PCA).

The next section describes how this data set was analysed using MDS to produce a set of statistical maps, and how other information was interpreted by means of the maps.

ANALYSIS

A variety of methods exist to analyse the information contained in the two-way table of variables by individuals. Since some variables are orderings while other variables are measurements on a ratio scale, it would have been sensible to use Multiple Correspondence Analysis (MCA) (reference). However, no members of the committee were familiar with MCA. Use of MCA might have introduced an element of esoterism in the discussion, and results might have been ignored. Most members of the validation team were, however, familiar with Principal Components Analysis (PCA), Factor Analysis, and Regression Analysis (reference). It was for this reason that Ordinal Multidimensional Scaling (MDS) and related techniques were chosen as analysis tools. MDS generates graphical representations, much in the same way as PCA does (reference). It can even be shown that PCA and MDS produce identical representations when certain conditions are met (Chatfield and Collins). MDS has, however, the advantage over PCA of being based on orderings,

and this is useful in the case of observations measured with error, or when discordant observations exist.

The aim of MDS is to create a statistical map in such a way that individuals that have much in common are located next to each other, and individuals who are very different are located far apart. The first step in a MDS analysis is the definition of a measure of dissimilarity. Many such measures exist (Coxon). The measure chosen in this case was created as follows. Variables were standardised to zero mean and unit variance. This is necessary because variables are measured in different units. It also implies that variables measured on an ordinal scale are treated as measured on a ratio scale. Much debate has taken place on the issue of doing arithmetic with ordinal variables (references). In theory, it should not be done but the consensus tends to be that, if the results make sense, one should not be too concerned about what the theory says. In other words, the credibility of the ends justifies unorthodox means. In this case, results were very much in line with what one would expect, and no discussion took place on the issue of doing arithmetic on orderings. The dissimilarity between any two individuals was the Euclidean distance between standardised variables.

A statistical map is next created on the basis of dissimilarity measures but a decision has to be taken on the dimensionality of the map. The decision was based on the observation of how the value of a measure of goodness of fit, Stress1, changed with the dimensionality of the space (reference). One would like to work on a low dimensionality representation - two or, at most, three dimensions - since higher dimensionality data is difficult to comprehend. However, it is often the case that five, or six dimensions are needed to represent the data, but that the relevant aspects of the problem are associated with only one or two of the dimensions, not necessarily dimensions 1 and 2 (reference). In this particular case, it was found that a representation in five dimensions gave an almost perfect

fit, but that only the first three dimensions were necessary for the purposes of the discussion at the validation committee. Thus, the map was produced in a five dimensional space, but only the coordinates of the first three dimensions were kept. Dimension 3 was found to have an interpretation but will not be discussed here, as it was not relevant to the validation decision. The projection of the five dimensional map on Dimension 1 and Dimension 2 is shown in Figure 1. Names have been changed in order to preserve confidentiality.

Figure 1 about here

Visual inspection is certainly a good start, but it requires familiarity with the individuals named. For example, Inés is a very junior member of staff, having just completed her degree. She has just been appointed to work at IFAMS. She appears at the bottom of Figure 1. At the top of Figure 1 we find Angel, a person who obtained his PhD over twenty-five years ago, and who has extensive teaching, research, and industrial experience. Similarly, other members of staff can be located in intermediate positions on the vertical axis of Figure 1, their location in the figure apparently being related to their level of seniority. It appears that the ordering along Dimension 2 is related to some aspect of seniority. But what aspect of seniority is the relevant one? It would have been possible to explore this issue using just verbal reasoning, but two statistical tools were used in the interpretation: Property Fitting (Pro-Fit) and Cluster Analysis (CA).

Pro-Fit is a regression-based technique that works in the same way as North-South directions in geographical maps ([reference](#)). We start with the hypothesis that the position of a member of staff on the map is related to some characteristic of this person, or Property. For example, Esteban is located at the bottom of the map, near Inés, so we suspect that Esteban is also a relatively junior

member of staff. Indeed, if we consult his CV we find that Esteban finished his degree only three years ago and that, after one year of work at industry, joined IFAMS two years ago. This suggests that there is a relationship between professional experience- measured by the variable PROFEX- and location on the map- measured by the coordinates of individuals in the space: DIM1, DIM2,... DIM5. This relationship can be formalised in the following way:

$$\text{PROFEX} = f(\text{DIM1}, \text{DIM2}, \dots, \text{DIM5})$$

In the absence of any other information, we assume that the relationship is linear:

$$\text{PROFEX} = \beta_0 + \beta_1 \text{DIM1} + \beta_2 \text{DIM2} + \dots + \beta_5 \text{DIM5} + \text{error}$$

This is just a regression equation. If it is indeed the case that the level of PROFEX is associated only with the position on dimension 2, we will find that only β_0 and β_2 will take non-zero values. In fact, the vector $(\beta_1, \beta_2, \dots, \beta_5)$ will tell us how PROFEX changes as we move along the map. This vector was calculated, standardised to unit length and its projection on the plane formed by Dimension 1 and Dimension 2 plotted in Figures 1. We are working with projections of a five dimensional vector on a plane. If the vector is orthogonal to the plane, it will just project as a point. The length of the vector gives, therefore, an indication of the importance of the dimensions. The remaining variables have been plotted in the same way. It can be seen in Figure 1 that PROFEX is indeed associated with Dimension 2, as the vector moves up relatively close to the vertical axis, and is relatively long in the projection.

Being regression-based, goodness of fit statistics are available as a bye-product of Pro-Fit estimation. Of particular relevance is the corrected R^2 . A low value for this R^2 would indicate that

the particular characteristic of the data is poorly captured in the map. In this particular case, the lowest R^2 found was 0.60, which is reasonable in this type of exercise, and all properties were plotted on the map.

We must remember that Figure 1 is a projection on two dimensions of points located in a five dimensional space. It is possible for two points to plot next to each other on the figure, while being far apart in the space. Cluster Analysis contours are particularly useful in this context, as points that belong to the same cluster are located near each other in the space. Cluster Analysis requires a measure of dissimilarity, and this was the same measure of dissimilarity that was employed in the MDS analysis. There are a variety of clustering methods that can be used. **Ward's method was preferred because it maximises within-group and so on (reference)**. The dendrogram can be seen in Figure 2. The contours of five clusters have been drawn in Figure 1.

Figure 2 about here

RESULTS

We are now in a position to interpret Figure 1 and to draw some lessons from this interpretation.

We see that vectors PRIOR, DEGREE, NOINT, EXPIN, PUBLICAT, and SEMGIVEN point towards the left hand side of the figure, indicating that staff located at the negative end of Figure 1, are better qualified, have held in the past more senior academic jobs, have published more in international journals, and have given more training seminars, than staff located on the right hand side of the figure. The vector that is most closely associated with Dimension 1 is PUBLICAT,

indicating that members of staff located on the left of Dimension 1 publish in international research journals, while members of staff located towards the right of this dimension either do not publish, or publish newspaper-type articles. Dimension 1 can, therefore, be labelled as “research orientation”.

Vectors that point towards the positive end of Dimension 2 are: PROFEX, SEMATTE, and TEACHY. This indicates that staff located towards the top of Figure 1 have more professional experience, have attended more training seminars, and have more teaching experience than staff located towards the bottom of the figure. Dimension 2 can, therefore, be labelled as “professional orientation”.

Cluster Analysis is also useful in the interpretation of Figure 1. Five clusters have been identified, one of them is located in the centre of the Figure, while the other four fall in the corners. We can see in Figure 1 that there is a cluster of staff formed by Carlos, Fernando, Tony, Esteban and Inés who are relatively junior in terms of both professional and research orientation, as they are located at the bottom right hand side of the figure. A second cluster, formed by Angel, María, Ana and Pedro groups individuals with much professional experience but relatively low research orientation. A third cluster that contains Pablo, Juan, and Rodi groups the individuals with the highest research orientation. Dina forms a cluster on her own; she appears to be highly research oriented, but with very little professional experience; or, at least, no indication of professional experience can be deduced from her CV. The picture is completed with a cluster in the middle of the figure formed by Oscar, Luis, and Hugo who appear to be average within the institution in every sense.

The map is based on dissimilarities and all these statements are relative. It is not the case that Inés is not qualified, but that she is much less qualified than, for example, Angel. The case of Inés has

already been discussed. Angel is a lecturer at UOP who holds BSc, MSc, and PhD degrees and has over ten years teaching and research experience at university level. In fact, anywhere in the academic world, Inés would be described as a junior member of staff, while Angel would count as a senior member of staff. One of the problems in MDS is precisely the absence of external benchmarks. Such benchmarks can be artificially added to the data set. It would be possible to add two imaginary members of staff, one with little qualifications and no experience, and another one who is highly research oriented and has excellent professional experience. The addition of such individuals would help to orient the maps and to better assess existing members of staff, but this is not necessary in the present case since both Inés and Angel represent well the two extremes. We conclude that the discussion of the merits of the request for validation can be based on the representation in Figure 1.

Up to this moment, all we have done is to compare members of staff on the basis of ten variables. This is interesting but does not help by itself in terms of the validation decision. In order to move on, we need to add to the picture information about the courses taught by members of staff.

In the presentation made to members of the validation committee, Figure 1 was augmented with information about the courses taught by individual members of staff. This is shown in Figure 3. For the purposes of this paper, only the level of the course has been added. The convention is as follows: a first year course lasting all year has been represented by a 1; a first year course taught during the first semester has been allocated 1.1; a first year course taught during the second semester is coded 1.2; second and third year courses were coded in the same way. Some courses were elective, and were only made available if enough students chose to do them; these courses were coded as E. We see, for example, that Hugo teaches an elective course, a second year course in the second semester, a third year course in the first semester, and a third year course lasting all

year. We also see that some individuals, such as Angel, appear not to be associated with any teaching.

We can now discuss validation issues, since we have put the information into context. It becomes apparent that IFAMS depends heavily on four individuals: Dina, Luis, Hugo, and Fernando. They are responsible for most of the compulsory teaching. They are relatively junior in terms of academic qualifications, or professional experience, or both. We see that if any of them was to leave, IFAMS would be in a very difficult situation and its viability might be compromised. Their views about IFAMS, about professional development, about support for continuing education, suddenly became an important issue to be explored. Having identified an important risk, the validation committee set itself the task of exploring IFAMS's contingency plans.

Figure 3 brought another aspect of the validation document to light. IFAMS, in its submission, named staff with extensive and relevant professional experience who are highly qualified; some examples are Pablo and Juan. But these appear to do little or no teaching at all. In fact, the impression that one gets is that their CVs have been added to the validation document in order to "inflate" it and to impress the validation committee. Another explanation is that they would become more involved as the institution evolved. The correct explanation was explored during the validation visit.

CONCLUSION

The coding and analysis of the validation document was important, but another important aspect of the exercise is simply engaging in it. The statistical framework used required attention to the details of the submission, details that might have been otherwise overlooked. The methodology employed

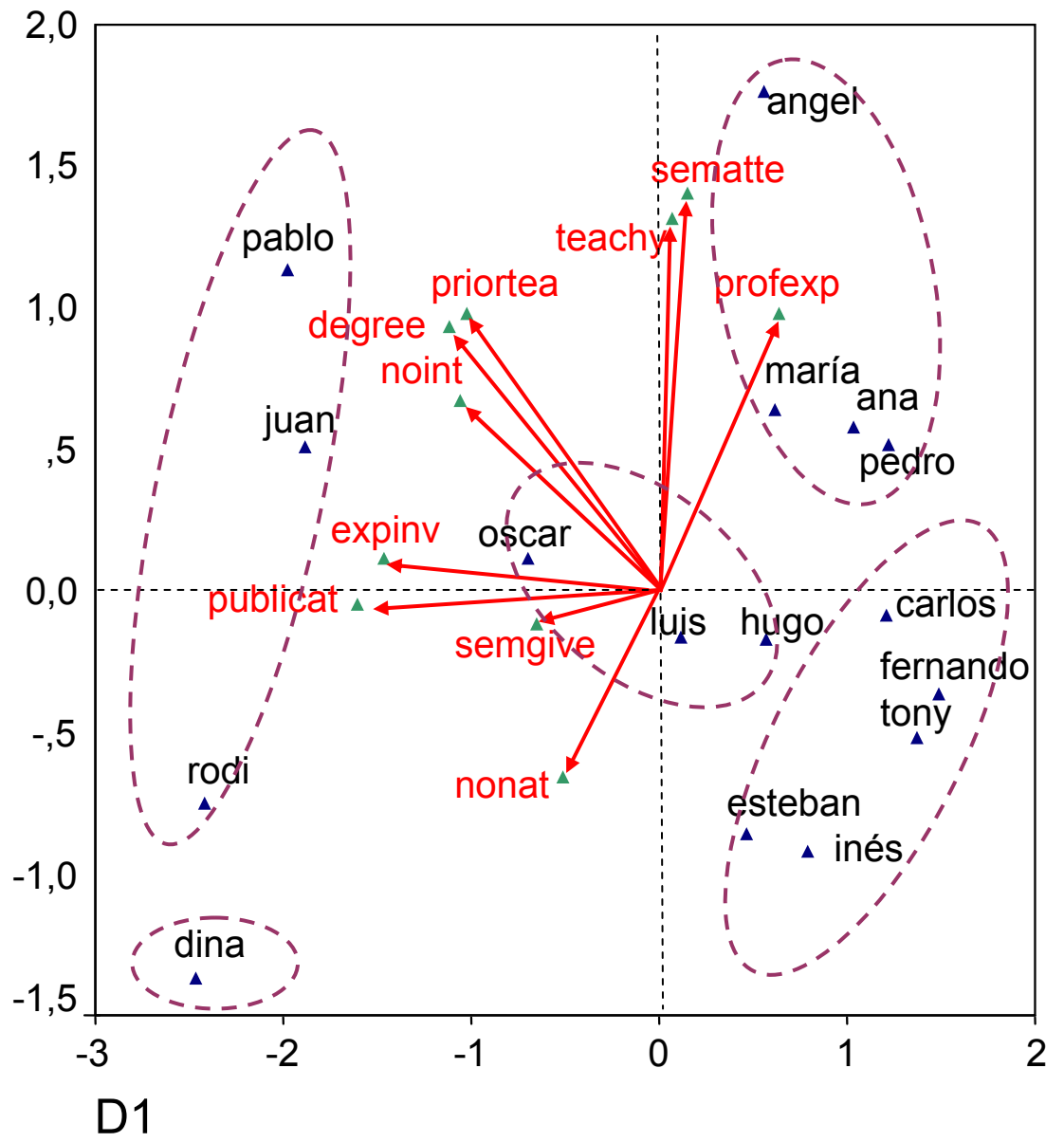
brought to light aspects of the request that needed investigation, and helped to structure the validation visit, and to define the areas that needed further exploration.

All the information collected was in the document, and a careful reader could have reached the same conclusions without the technical apparatus, but the use of statistical instruments, while not totally removing subjectivity, helped to base discussion on facts and not on opinions.

There were aspects of the submission that went beyond the analysis presented here. The committee still had to assess if administrative processes, premises, student selection, and so on were satisfactory. These are matters of judgement. The report of the committee could never have based solely on the results of a statistical analysis. The statistical analysis was a quantitative tool that helped to arrive at a set of recommendations: it was used in a qualitative way. The decision to go for pictorial representations was crucial.

The committee recommended that Senate should approve validation after some of the issues identified during the validation process had been satisfactorily addressed.

D2



* * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * *

Dendrogram using Ward Method

